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INSPECTION of the improvement of the South Pass of the Mississippi River, 1447.

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REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

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REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

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ANNUAL REPORT OF THE MISSISSIPPI RIVER COMMISSION FOR THE FISCAL YEAR ENDING JUNE 30, 1898.

ARMY BUILDING,
New York City, July 1, 1898.

SIR: The Mississippi River Commission has the honor to submit its annual report for the fiscal year ending June 30, 1898.

APPROPRIATIONS AND ALLOTMENTS.

The appropriation in the sundry civil act of June 4, 1897, was allotted as follows:

Dredges and dredging		$763,300
Secretary's office:		
For Mississippi River Commission	$38,000	
For surveys, gauges, and observations	67,710	
		105,710
Levees		1,674,200
Bank revetment at Giles Bend		125,000
Care and preservation of plant, First and Second districts		40,000
Care and preservation of plant, Third district		40,000
Care and preservation of plant, Fourth district		20,000
Purchase of towboat, Third district		35,000
Preservation of work, Hopefield Bend		20,000
Reserve for emergencies, to be used at the discretion of the president of the Commission		110,123
Total		2,933,333

The amount of the appropriation in the deficiency act approved July 19, 1897, had been previously allotted as follows:

Dredges and dredging (construction, inspection, and tests of two new dredges, *Epsilon* and *Zeta*, and care of dredges)	$254,000
Levees, project of June 22, 1896	281,250
Lake Providence Reach	89,750
Total	625,000

The Commission has been in session four times during the year, the seventy-second session, February 2 to 7, 1898, being at St. Louis, Mo., and on the steamer *Mississippi* on an inspection trip to New Orleans, La. The usual fall inspection trip was omitted on account of the prevalence of yellow fever along the lower river. The spring inspection trip was made earlier than usual to meet the convenience of the subcommittee of the Senate Committee on Commerce. Four members of that subcommittee, viz, Hon. Knute Nelson, chairman; Hon. George G. Vest, Hon. J. H. Gallinger, and Hon. James A. Berry, accompanied the Commission. Other guests were Hon. T. C. Catchings and Mr. Willis Moore, Chief of the Weather Bureau. The subcommittee was afforded every facility for observation and for taking such testimony at different points as they desired.

OPERATIONS IN CHARGE OF THE SECRETARY OF THE COMMISSION.

Surveys.—During the summer of 1897 the field work of topography and hydrography of the Mississippi River was extended from Brownsville northward to the upper limits of Fort Snelling Reservation, about 7 miles above the steamboat landing at St. Paul, and included—

Main river survey (channel distance)	miles..	175
Topography	square miles..	500
Hydrography	do....	84.5

An extension of the survey beyond St. Paul having been authorized, preparations have been made to begin the work.

Special surveys.—A resurvey of that part of the lower river from Scot Bluff to Carrollton was completed in January, 1898, its object being to afford means of comparing later conditions of the river with those of earlier surveys.

The line of precise levels which was run between New Orleans and the Gulf in 1892–93 showed a subsidence of the lower end of the Delta. To obtain further data upon this question a level line was run from the hills at Baton Rouge to the end of the jetties at the mouth of the river. This work was completed March 19, 1898. Preliminary computations indicate that the subsidence has continued since 1892.

Gauges.—The permanent gauges of the river have been maintained; also a continuous tide gauge at Biloxi, Miss. This latter has a continuous and exceptionally good record of between two and three years, which will permit the establishing of a close approximation of mean Gulf level at this point.

In addition to the permanent gauges on the river, high-water gauges at intervals of 5 miles have been maintained to determine the high-water slope.

Observations.—Discharge measurements at or near high and low water were made at Columbus, Ky.; Helena, Ark.; Arkansas City, Ark.; Warrenton, Miss.; Red River Landing, La., and Carrollton, La.; also on the tributaries at or near their mouths.

Mapping, etc.—Charts 150 to 157, inclusive, scale 1:20,000, covering the river from Davenport, Iowa, to Arnolds Landing, Ill., 82 miles, have been completed and published. Charts 158 to 160, inclusive, have been completed, and 161 to 164, inclusive, are under way. Inch-mile sheets 121 to 124, inclusive, reaching 597 miles above Cairo, have been completed, and 121 and 122 published. Three sheets of upper alluvial valley have been published.

Dredges and dredging.—At the beginning of the fiscal year there were two dredges on hand, the *Alpha* and *Beta*, and two others, the *Gamma* and *Delta*, about finished and ready for testing. During the year two others, the *Epsilon* and *Zeta*, were completed. The *Alpha* has been furnished with a new pump and otherwise repaired.

The *Beta*, having been found too unwieldy for successful work on account of her great draft, is now having her hull enlarged to reduce the draft and other quite extensive alterations made, changes that have been found necessary by the experience of the past season's work.

The comparative tests of the *Epsilon* and *Zeta*, dredges of identical build, except that the former has a water-jet agitator and the latter a mechanical agitator, seem to indicate a decided superiority in favor of the former, for materials generally met with in the bars obstructing navigation in the Mississippi River.

During the year one pile-sinker hull has been constructed and contracts entered into for four more.

One small steam tender was completed and three others contracted for.

Proposals for five large steam tenders have been received.

The plans and specifications for the seventh dredge, the *Iota*, which is to be self-propelling, have been completed, and advertisement for proposals for its construction will be published soon.

Dredging operations.—The four new dredges added to the plant during the year have been tested for efficiency and capacity, and all were found to be equal to the contract requirements.

The project for carrying on the dredging work in channels during the past season was to distribute the four available dredges between Cairo and Graves Bayou, each dredge being assigned to a particular reach of river. They worked on fourteen different bars with more or less favorable results. In some cases the required depth of 9 feet was maintained, in other cases as little depth as 6 feet. In most cases the dredged channels are reported to have given depths of from 8 to 9 feet.

The bars worked upon were Medleys, Upper Point Pleasant, Sam Phillips, Lazelles, Batsells, Hathaway, Gold Dust, Rocky Point, Osceola, Island 34, Island 40, Presidents Island, Fleeces, and Graves Bayou, all but the last three being above Memphis. A depth of more than 7 feet was maintained between Cairo and Memphis during low-water season, except between September 20 and November 10, when only 6 and 6½ feet existed at Sam Phillips.

The work was somewhat interfered with by the yellow fever breaking out on the dredge *Alpha* while lying at East Cairo, which kept her from work until October 12, 1897. During the coming season it is expected to have six dredges at work. This increase of 50 per cent over the working force of last season, together with the experience gained in selecting channels and conducting the work, should produce more positive results in maintaining low-water navigation.

For full details concerning the dredges and the dredging operations attention is invited to the report of the Secretary of the Commission, Appendix 1.

CONSTRUCTION OTHER THAN LEVEE BUILDING.

No construction work within the river banks has been done during the year, except repairs to various revetments and the beginning and considerable advancement of the bank protection in Giles Bend to prevent the threatened cut-off above Natchez, Miss.

FIRST DISTRICT (CAIRO, ILL., TO FOOT OF ISLAND NO. 40, 220 MILES).

District officer, Capt. Mason M. Patrick, Corps of Engineers, U. S. A.

The channel and harbor works in this district are at Columbus, Ky., Hickman, Ky., New Madrid, Mo., and Plum Point Reach.

Columbus, Ky. (*21 miles below Cairo*).—The work here consists of a series of five spurs built to prevent caving of the bank at and below the town. The work is in fair condition and effective. No further work at present contemplated.

Hickman, Ky. (*36 miles below Cairo*).—The work here is a bank revetment constructed to prevent serious caving of the bank in front of the town. It is in fair condition and no further work contemplated at present.

New Madrid, Mo. (71 miles below Cairo).—The work here is bank revetment to prevent caving of the bank. One thousand six hundred feet of bank has been protected, and protection of at least 1,200 feet more is needed, at an estimated cost of $40,000.

Plum Point Reach (147 to 186 miles below Cairo).—The work here extends from Daniels Point to Craighead Point, Arkansas, a distance of about 20 miles, and consists of bank protection, and closure of chutes by means of pile dikes and a brush and stone dam. The result has been the protection of considerable lengths of bank, and an increase of depth over the crossings in low water, which has varied in different years, but has averaged about 3 feet.

The works are bank revetments at Daniels Point, Ashport Bend, Fletchers Bend, Osceola Bar, Bullerton Towhead, and Plum Point; a brush and stone dam and pile dikes to close Gold Dust Chute, pile dikes to close Osceola and Bullerton chutes, and pile dike to contract the channel below Plum Point.

The different works along the reach are holding fairly well, but there are a number of places where slight failures have occurred, and the unprotected portions of bank have caved badly during the past two years. This is especially threatening to work in Fletchers Bend, where caving above the revetted part has been excessive, and has destroyed 620 feet of the upper part of the revetment.

The Gold Dust brush and stone dam has settled somewhat. For details of operations in this district attention is invited to the report of Capt. Mason M. Patrick, Corps of Engineers, U. S. A., Appendix 2.

SECOND DISTRICT (FOOT OF ISLAND NO. 40 TO MOUTH OF WHITE RIVER, 180 MILES).

District officer, Capt. Mason M. Patrick, Corps of Engineers, U. S. A.

The channel and harbor works in this district are at Hopefield Bend, Memphis Harbor, mouth of Wolf River, Nonconnah Rock and Helena Harbor.

Hopefield Bend (227 miles below Cairo).—The work here consists of bank protection for 16,000 feet from Mound City Landing to Hopefield Point, the maintenance of which is of vital importance to the harbor of Memphis. Some damage was done to this work by the high water of 1897, and the sum of $20,000 was allotted for repairs. These repairs were completed in December, 1897.

Memphis Harbor (230 miles below Cairo).—The work at this point consists of bank revetment and a series of spur dikes built to protect the bank for about 12,372 feet; the revetment was built by the Government and the dikes by the citizens. In addition to this, a short length of bank at the end of the bridge has been protected by the bridge company. There is a gap of about 1,200 feet of unprotected bank which should be covered, at an estimated cost of $36,000. Some damage was done to the work by the high water of 1897, which was repaired during the past season.

Wolf River mouth at Memphis, Tenn.—The River and Harbor Act of June 3, 1896, made available for the improvement of this river the sum of $35,000. The approved project provided for dredging and the removal of sunken logs, snags, and other obstructions. Under contract, a considerable quantity of material, and some obstructions, were removed during the season, but owing to unforeseen difficulties the contract was terminated, and the district officer proposes to purchase a plant for the continuation of the work, for which about $30,000 is available.

Nonconnah Rock (*236 miles below Cairo*).—This obstruction is a ferruginous sandstone and cemented gravel about 4 miles below Memphis bridge, which is dangerous to navigation on account of lack of depth of water over it. Part of it has been removed in previous years, and the completion of the project to obtain a depth of 8 feet over it at a zero stage on the Memphis gauge is estimated to cost $3,000.

Helena Harbor (*306 miles below Cairo*).—The work at this point consists of bank protection partly by revetment and partly by spur dikes. The protection covers a length of about 4,110 feet and should be extended for 1,000 feet, at an estimated cost of $30,000. The existing work has been more less damaged in many places and considerable repairs are urgently needed.

For details of operations in this district attention is invited to the report of Capt. Mason M. Patrick, Corps of Engineers, U. S. A., Appendix 2.

THIRD DISTRICT (MOUTH OF WHITE RIVER, ARKANSAS, TO WARRENTON, MISS., 220 MILES).

District officer, Capt. H. C. Newcomer, Corps of Engineers, U. S. A. The channel and harbor work in this district are at Lake Bolivar Front, Ashbrook Neck, Greenville Harbor, Lake Providence Reach, and Delta Point.

Lake Bolivar Front (*417 miles below Cairo*).—The work at this point consists of bank protection to prevent the threatened destruction of a large levee across the head of Lake Bolivar. A bar is forming in front of the revetment and the work is in fair condition with exception of three small breaks in upper bank paving. No further work is contemplated here except possibly small repairs.

Ashbrook Neck (*446 miles below Cairo*).—This work consists of bank protection to prevent a threatened cut-off. Considerable damage was done to this work by the high water of 1897, but little below low-water line. Repairs were made at a cost of $13,249.53, and the revetment appears in effective condition for a length of about 9,990 feet. No extension is deemed necessary, but further repairs may be needed after the subsidence of the flood.

Greenville Harbor (*478 miles below Cairo*).—The work at this point consists of bank protection partly by spur dikes and partly by revetment to prevent the destruction of the city of Greenville, Miss. The work has been subjected to many vicissitudes. Commenced in 1887, twelve spur dikes were built, the bank above them not being protected. In the flood of 1891 four of the dikes were carried away by a flank attack due to the caving of the bank above, and in the flood of 1894 one more spur dike was destroyed. In the meantime continuous revetment, starting some distance above the dikes, afterwards extended down to them, was commenced, and up to this time built to a length of about 12,165 feet.

This revetment has been repeatedly broken. In 1893 and 1894 the upper bank paving required repairs. In 1896 a break required 677 feet new revetment for repair. In 1897 the great flood caused serious damage. One thousand eight hundred and fifty feet of new revetment was built during the past season in repair of one break, and a number of minor repairs made. On February 19, 1898, after the January rise of this year, four breaks were discovered; on March 6, a fifth, and on

March 12, a sixth break. Other defects, it is thought, will appear when the water subsides.

In order to place this front in a condition of apparent stability, considerable additional work will be required, involving the relocation of the levee line farther inland and the strengthening and rebuilding of the bank revetment for an estimated distance of nearly 1 mile. No extensive extension of the revetment is recommended at this time. The rebuilding of the bank revetment concerns particularly the protection of the town of Greenville as a harbor, and the expense therefor should be provided by a special item in the appropriation bill.

Lake Providence Reach (*517 to 552 miles below Cairo*).—This was one of the reaches first selected by the Commission for systematic treatment. Most of the works have for various reasons become useless or are destroyed. This was partly due to the insufficient strength of the earlier work and partly to the restraint placed upon the Commission at one time, forbidding the construction of bank protection, which was a vital part of the contemplated improvement of the reach. The least low-water depths on its crossings before its improvement was undertaken are variously reported as 4½ and 5 feet. The original project provided for giving the low-water channel an approximately uniform width of 3,000 feet by constructing contraction works, closing all the chutes and holding the caving banks. Instead of covering the entire reach of 35 miles, however, as originally intended, the works as built were confined to a reach of about 20 miles, from 522 to 542 miles below Cairo. Operations were begun in 1882 and actively prosecuted until 1885, and some repairs were made to these earlier works by 1886 and 1888–89. The Duncansby, Mayersville, Baleshed, and Stack Island systems of dikes were constructed on the Mississippi side of the channel and the Cottonwood and Elton systems on the Louisiana side, and bank revetment was constructed at Louisiana Bend and Mayersville Island. The total lengths of the various constructions were about as follows: 112,396 feet of pile dikes, 48,238 feet of foot mats between dikes, 16,547 feet of foot mats along the dikes, 5,588 feet of screens in front of the dikes, 13,561 feet of wattling between dikes, 520 feet of shore revetment at the ends of dikes, and 33,476 feet of bank revetment. (See Annual Report of 1895,page 3843, for a tabular summary of the work.) The details of these works are given in the Annual Reports of 1883, page 2285; 1884, page 2814, and 1885, pages 2748 and 2960. Maps accompany the reports of 1883, 1884, 1888, and 1889.

These earlier works had a beneficial effect on the channel, but they were comparatively weak and difficult to maintain. The Duncansby system was reported as practically destroyed in 1886, the Louisiana Bend revetment by 1887, and by 1889 only portions of the system at Baleshed Bar and Stack Island remained out of all the works that had been built. Parts of these are still in existence where not exposed to the destructive action of the river.

Louisiana Bend Revetment (*522 R.*).—In 1889 active work was resumed. It was decided to revet the caving bank near the head of the reach in Louisiana Bend, hoping thus to give greater permanence to the channel throughout the reach. About 6,024 linear feet of revetment were built in 1889–90, 5,224 feet in 1891–92, and 5,835 feet in 1892–93, when further operations were suspended awaiting the results of the experiments with dredging. The type of revetment used was much stronger than that formerly employed, consisting of woven mats below water, 260 to 345 feet wide, and upper bank paving of stone 10 inches thick.

Details of the work are given in the Annual Reports of 1890, page 3229; 1892, page 3177, and 1893, page 3754. A map accompanies each of these reports.

On account of the unstable nature of the bank it was necessary to make some repairs each year to the upper bank paving, where sloughs occurred during low-water stages, and in 1892 and 1893 seven short spur dikes of brush and stone were built on the upper bank, across the mouth of Old River, where the high waters caused scouring behind the revetment. In 1896–97 a break in the revetment at range 126 was repaired by the construction of about 484 linear feet of new revetment, and about 763 feet of revetment were built at the lower end of the work, where about 1,200 feet had been gradually lost by the caving of the bank. After the flood of 1897 a number of breaks appeared between ranges 127 and 156. Provision was made in project of July 31, 1897, for repairing the only break that was then visible, but later on other breaks appeared, and under date of January 15, 1898, the district officer reported to the president of the commission as follows:

> A survey was made in December, 1897, and three blue prints showing the results of the survey as compared with the surveys of June, 1896, and July, 1897, are forwarded in separate package.
>
> An examination of these drawings will show that considerable changes were effected during the last high water (and also after the high water at ranges 130 and 131), throughout the greater part of the interval between the new mats sunk in December, 1896. This revetment was built during the low-water season of 1892. The river is very narrow and deep at this point, the width being especially small before the last high water, as shown on the index sheet by the position of the bar line in June, 1896. The last flood enlarged the section, pushing the bar line back and causing considerable scour through the revetment. When I inspected the work shortly before submitting project of July 31 for repairs to revetment in the Third district, only the upper break about range 126 was visible, and provision was made for repairs at this point in case they should appear necessary at a lower stage of water. When the other breaks appeared, a survey was made and it became evident that no effective repairs could be undertaken this year with the plant and money available. To make thorough repairs would practically require the renewal of the revetment from range 127 to range 156, a distance of about 2,900 feet, at an estimated cost of about $87,000.
>
> The available balance for Lake Providence Reach is about $16,000. It seems doubtful whether the benefit to be obtained by maintaining the revetment would justify this additional expenditure, and I, therefore, do not recommend that this broken revetment be repaired unless it is the policy of the commission to hold the work intact.
>
> The mattress construction in this portion of the revetment was of the woven type. Fascine mats might prove successful in holding the present bank, which consists of material deposited in the channel of Old River. If the caving be allowed to extend back several hundred feet to the bank of Old River Island a better foundation for the work would be secured.

No work of construction has been done here during the year.

Lake Providence Revetment (*540 R.*).—This revetment was built to hold a rapidly caving bank that threatened to destroy the important levee across the foot of the lake and the town of Lake Providence. About 4,780 linear feet of revetment were built in the season of 1894–95 and 5,360 feet in the following season, 1895–96. The details of the work are given in the Annual Reports of 1895, page 3806, and 1896, page 3053. A map of the work accompanies the Report of 1896.

During the past season slight repairs, costing about $822.75, were made to the upper bank paving near the lower end of the work, where some small holes had been washed out near the top of the bank by the flood of 1897. No extension is considered necessary in the near future. The length of revetment in good condition is about 10,090 feet measured along the shore edge of the mats.

The following table gives the least depths reported on crossings in Lake Providence Reach for the different years:

Date.	Crossings.	Depth on crossing.	Reading of Providence gauge.
		Feet.	*Feet.*
1879	Stack Island	5	0.55
1884, Aug. 30	....do	10	8.9
1885, Oct. 20	Ben Lomond	13	7.1
1886, Sept. 30	Stack Island	8.5	4.7
1887, Sept. 30	....do	7	4.5
1888, Oct. 23	....do	9	5.75
1889, Nov. 1	Ajax Bar	7	2.25
1890		11	8.5
1891		7	10
1892, Oct. 23	Ajax Bar	5.5	1
1896, Oct. 30	Wilsons Point	12	1.6
1897, Oct. 11	....do	7	—2.2

Extreme low-water depths of 6 to 7 feet have been reported for the years 1893–95.

Delta Point (*598 miles below Cairo*).—The work at this point consists of bank revetment placed to prevent the recession of the bank and to hold the river against the lower part of the city of Vicksburg, Miss. Prior to 1882, when this work was placed under the supervision of the Commission, 5,400 feet of revetment, one mattress spur dike, and two screen dikes had been built. Since 1882 6,448 feet of revetment have been placed. Practically all of the work prior to 1882 is destroyed or covered by later work. After the flood of 1897 it was found that the work had been damaged, and there had been some caving of bank above the work. Repairs have been made at a cost of $3,020.28, but needed extension was postponed. The lower end of the work is covered up by deposit, so that the part now exposed to attack is the upper 1,065 feet, of which about 900 feet is in effective condition. The improvement of Vicksburg Harbor proper is now in charge of the Engineer Department.

The Commission again recommends that the work at Delta Point be transferred to the Vicksburg Harbor improvement, of which it really forms a part, and which is carried on under a specific appropriation.

For full details of the operations in this district, attention is invited to the report of Capt. H. C. Newcomer, Corps of Engineers, U. S. A., Appendix 3.

FOURTH DISTRICT (WARRENTON, MISS., TO HEAD OF THE PASSES, LOUISIANA, 453 MILES).

District officer, Lieut. Col. George McC. Derby, U. S. Volunteers, captain, Corps of Engineers, U. S. A. The works of channel and harbor improvement in this district include the harbors of Natchez, Miss., and Vidalia, La., improvement at the junction of the Mississippi, Red, and Atchafalaya rivers, harbor of New Orleans, and dredging of bars below Natchez.

Harbors of Natchez, Miss., and Vidalia, La. (*700 miles below Cairo*).—The object of the work in this vicinity is to prevent a threatened cut-off across Cowpen Neck, which would cause the destruction of the town of Vidalia, injure the water front and landings at Natchez, and have a deleterious effect upon many miles of river above and below.

The project for work contemplates the construction of a levee along the axis of Cowpen Neck to prevent the flow of water across it, and the construction of about 1,600 feet of bank protection in Giles Bend, above the neck, estimated cost $541,300. In June, 1897, the commission allotted $150,000 for this work, which, with balance then available, provided the sum of $259,529.17. Amount previously expended was $122,722.87. During the year the enlargement of the levee on Cowpen Neck to a grade of 5 feet above high water of 1890 was completed. The work of protecting Giles Bend was commenced about July 1, 1897, and continued until the end of December, when high water stopped the work. Fifteen spur dikes were placed generally about 450 feet apart and protecting altogether a length of 7,060 feet of bank. Some new features were adopted in the method of building and placing the spurs, resulting in a very considerable saving in cost; and if they prove as effective and durable as is hoped, previous estimates of the cost of the work will be reduced. The prevalence of yellow fever, and the quarantines established along the river in consequence thereof, rendered the prosecution of this work particularly trying; and the officer in charge, and his assistants having direct control of operations, are to be congratulated upon the manner in which they were carried on and the splendid progress made.

Junction of the Mississippi, Red, and Atchafalaya rivers, Louisiana (764 miles below Cairo).—Detailed descriptions of the difficulties encountered in this vicinity and plans for work adopted will be found in previous annual reports. The works at present relied upon for relief are two submerged sills crossing the Atchafalaya about 5 miles below its head, to prevent its enlargement, and the annual dredging of lower Old River to maintain a navigable channel between the three rivers. An hydraulic dredge boat especially designed for the work has successfully maintained the navigable channel for the past four seasons, at moderate expense. Careful examinations were made during the low water of the year in the vicinity of the submerged sills in the Atchafalaya. They were found to be in fair order, though some settling had occurred since the last examination, and the extensive shoaling of the river reported last year was scoured out by the great flood of 1897 to substantially the same depths that existed in 1894. It is probable that the sills will require extensive repairs in the near future.

The dredge removed 51,940 cubic yards of material from Old River, dredging for a navigable depth of 5½ feet at extreme low water. Navigation was uninterrupted.

New Orleans Harbor (966 miles below Cairo).—The work in this harbor has for its object the protection of the banks from caving, which destroys a very large amount of valuable property. The work consists of bank revetment and spur dikes, and has been placed in Carrollton Bend, Greenville Bend, Gouldsboro Bend, and the Third District Reach. During the year no work was done with the small balance available on account of the necessity of using the plant at Giles Bend. During the month of November, 1897, serious caving occurred at Algiers Point and in the Third district below the last spur of the system.

The cave at Algiers Point destroyed a great deal of valuable property. A project for work at the latter point has been approved, and work will be commenced when the river reaches a suitable stage. The project contemplates an extension of the Gouldsboro system of spur dikes.

The amount available for the commencement of this work is quite small. The urgency of the improvement at this and other points in the harbor, and the importance and dignity of the harbor, are such as would appear to make it highly advisable to make available for each year's work a sufficient amount to permit an energetic prosecution of the protection of the banks at all points where needed within the harbor limits.

Dredging bars below Natchez.—The bars at Natchez Island, Fords, Torras, and Tunica caused some difficulty to navigation during low-water season. A dredge was sent to Fords on November 27 to render such assistance as was required, but no dredging became necessary, and it was withdrawn on December 12.

For full details of the operations in this district attention is invited to the report of Capt. George McC. Derby, Corps of Engineers, U. S. A., Appendix 4.

SURVEYS, PLANT, ETC., UNDER DISTRICT OFFICERS.

First and Second districts.—Surveys were made near Point Pleasant to determine damage to the levee by caving river bank, of Plum Point Reach and Memphis Harbor, including Hopefield Bend. The latter shows that but little change has taken place in the past two years. Most of the plant of these districts is now placed near Memphis. It is in fair condition, but requires constant repairs, which are estimated to cost $25,000 per year. One new towboat, the *Chisca*, was added to the plant at a cost of $25,900.

Third district.—Surveys were made at Carters Neck and Caulks Neck to determine the rate of caving; also of the different revetments throughout the district. Repairs to plant were made during the year at a cost of $19,396.90, and the cost of caring for it amounted to $21,438.37. Work upon the construction of a new steel-hull towboat under contract was commenced in April, the boat with outfit to cost $37,450.

Fourth district.—Surveys were made at Algiers Point and at the sill dams in the Atchafalaya River. The plant in the district is generally in excellent condition, though inadequate for the service, and additions are necessary. Eighteen pieces were condemned and disposed of. Contract has been entered into for construction of a steel towboat. Repairs were made at a cost of $9,380.89, and the care of plant cost $3,821.43.

LEVEES.

From the appropriation in the sundry civil act of June 4, 1897, the sum of $1,674,200 was allotted by the commission to levees and apportioned to districts as follows:

Lower St. Francis	$63,550
Upper Yazoo	73,000
White River	123,300
Upper Tensas	299,400
Lower Yazoo	551,300
Lower Tensas	228,700
Atchafalaya	138,600
Lafourche	41,600
Barataria	19,400
Pontchartrain	113,150
Lake Borgne	22,200

Subsequently the following additional amounts were allotted by the president of the commission from the unallotted balance of the appropriation:

For surveys, gages, and observations, fourth district	$500
For Walnut Bend Levee, Lower St. Francis district (preservation of works at)	30,000
For Delta Point (preservation of works at)	6,000
For stone	30,000
For Lower Yazoo Levee district	10,000
For Upper Tensas Levee district	20,000
For White River Levee district	5,000

Levee building during the year has been carried on vigorously, but under difficulties. The work in almost all of the districts, but more especially in the lower ones, was hampered by the quarantines established by local authorities on account of the prevalence of yellow fever. Exceedingly heavy rainfalls in December and floods in the river in January and April added to the difficulties of the season's work. The crevasses of the previous year were all closed with the exception of the following in the White River Levee district: Modoc, Nos. 1 and 2 (336–337 R.), Hughey (337½ R.), Dixie (340 R.), and Schoolhouse (342 R.). The aggregate length of these openings was about 6,500 feet.

Much the greater part of the work of the year has been devoted to the enlargement of the levees.

The reports of the year's work show that a total of 15,786,049 cubic yards of earth has been placed in the levees, of which 9,179,851 cubic yards were built by the United States and 6,606,198 cubic yards built by local authorities.

The following summaries of levee operations in the various districts are presented. For fuller details attention is invited to the reports of the district officers, Appendixes 2, 3, and 4.

Lower St. Francis Levee district, right bank (80 to 298 miles below Cairo).—The area that will be protected by the levees when completed will be 3,490 square miles. Revised locations will make the levee line 215 miles long. Below Pecan Point the St. Francis levee board constructed during the year 17½ miles of levee. The total length of continuous line now is 122½ miles. Near Walnut Bend there is a line 6 miles long which will form part of the continuous line, leaving to be constructed for the complete closing of the basin about 86½ miles. The last annual report showed that there were 13 breaks in the line. In addition to the breaks there were six places where failure occurred in the Walnut Bend levee. The available money was used this year in closing the breaks and doing some repair and enlargement. Work done from May 1, 1897, to April 30, 1898, was—

	Cubic yards.
By United States	615,686
By the local levee board	566,156
Total yardage built by the United States previous to April 30, 1897	2,852,124
Total yardage built by others previous to April 30, 1897	3,575,124
Loss during the year by abandonment	569,666

The average cost of work by the United States this year, including office, engineering, and superintendence, was 14.21 cents per yard.

For high-water protection $2,652.37 was expended.

The aggregate in this district is—

	Cubic yards.
By United States	3,014,810
By others	4,024,614

The high water of this year developed many weak places.

To enlarge the existing levees to a grade 4 feet above the 1898 water will require 4,000,000 cubic yards of earth.

White River Levee district, right bank (306 to 385 miles below Cairo).—The length of this district by levee line is 64.4 miles. The territory to be protected is a strip from 8 to 30 miles wide. At date of last annual report there were 14 crevasses, about 17,000 feet in length. The money allotted for this district was insufficient to close all of the crevasses, and it was decided to leave open those near the middle of the line. The work done from May 1, 1897, to April 30, 1898, was—

	Cubic yards.
By United States	756,656
By local authorities	11,800
The total yardage built by the United States previous to May 1, 1897, was	5,225,958
The total yardage built by local authorities previous to May 1, 1897, was	1,007,086

The average cost of United States work, including office, engineering, superintendence, etc., was 15.15 cents per yard.

For high-water protection there was expended by the United States, $5,492.80.

The aggregate of effective levees in place is—

	Cubic yards.
Erected by United States	5,337,478
Erected by others	1,018,886
Total	6,356,364

The grades are too low and dimensions of levees must be much increased. To close breaks and raise levees to 4 feet above water of 1897 will require 6,000,000 cubic yards of earth.

The recent high water developed many weak places.

Upper Yazoo Levee district, left bank (*244 to 365 miles below Cairo*).—The length of levee line is 123.88 miles. Territory protected, 3,281 square miles. At date of last annual report there was one crevasse (Flower Lake) in this line. The flood of 1897 showed that the entire line is too low. The local levee board closed the Flower Lake crevasse and did much toward bettering the line. The money allotted to this district was used for the enlargement of the levee at various points. During the year from May 1, 1897, to April 30, 1898, the work done was—

	Cubic yards.
By the United States	288,702
By local levee board	2,467,219
Total yardage built previous to May 1, 1897, by the United States	4,351,669
Total yardage built previous to May 1, 1897, by the local authorities	8,585,556

The average cost for work done by the United States this year, including office, engineering expenses, etc., was 17.49 cents per yard.

The United States expended for high-water protection, $3,953.68.

The following is a summary of levees in place April 30, 1898:

	Cubic yards
Erected by United States	4,415,261
Erected by levee board	10,266,9[illegible]5

Estimated yardage required to enlarge to grades indicated by high water of 1897 is 18,000,000 cubic yards.

Yellow fever and the January rise in the river interfered materially with the work.

Lower Yazoo Levee district, left bank (*365 to 592 miles below Cairo*).—The levee line is continuous from the upper end to Eagle Lake. The line is about 187.1 miles in length. The main line contained on May 1, 1897, 21,911,246 cubic yards, of which the United States built 6,962,600 cubic yards. During the year there have been added 4,118,148 cubic yards by the United States and about 227,463 cubic yards by the local board. The length of line thrown out by crevasses and new loops was 32,137 feet, containing 733,421 cubic yards. The provisional grade adopted is 3 feet above water of 1897, and it is estimated that 6,366,000 cubic yards will be required to bring the levees to this grade after completion of existing contracts. Work was much retarded by yellow fever, excessive rains, and the January flood. The United States expended about $5,350 in high-water protection, and it is stated that the levee board expended $90,000.

Upper Tensas Levee district, right bank (402 to 606 miles below Cairo).—The line of levee is continuous for a distance of 172.1 miles. The total yardage on May 1, 1897, was about 21,996,612 cubic yards, the United States having built about 15,396,220 cubic yards. During the year there have been added 1,403,977 cubic yards by the United States and about 641,561 yards by local authorities. Length of line thrown out by crevasses and new loops 9,066 feet, containing about 330,622 cubic yards. The provisional grade adopted is 3 feet above water of 1897, and it is estimated that it will require about 7,089,000 cubic yards to bring levees to this grade after completion of existing contracts. The small crevasse in Amos Bayou line and the Biggs and Reed crevasses were closed. The expenditure for high-water protection was $5,019 by the United States and about $5,347.18 by the local authorities.

Lower Tensas Levee district, right bank (606 to 764 miles below Cairo).—The line of levees is continuous from the head of the district opposite Warrenton to a point about 26 miles above the mouth of Red River. The total yardage on May 1, 1897, was about 12,927,065, of which about 66 per cent was built by the United States. During the year to May 1, 1898, the United States added 1,014,257 cubic yards, and local authorities added 475,966 cubic yards. There were lost by abandonment during the year 107,618 cubic yards. The provisional grade adopted for levees is 5 feet above highest water.

Atchafalaya Levee district, right bank (764 to 886 miles below Cairo).—The district extends from the mouth of Red River to the mouth of the Lafourche. The line is continuous. The total yardage on May 1, 1897, was 13,890,122 cubic yards, of which the United States built 65 per cent. During the year to May 1, 1898, there were added by the United States 261,157 cubic yards, and by local authorities 1,297,167 cubic yards. There were lost by abandonment during the year 169,404 cubic yards. The greater part of the new work by the United States raises the levees from 5 to 6 feet above highest water.

Lafourche Levee district, right bank (886 to 957 miles below Cairo).—This district extends from the mouth of Bayou Lafourche to New Orleans. The line is continuous. The total yardage on May 1, 1897, was 6,583,042 cubic yards, of which the United States built 61 per cent. During the year there were added by the United States 78,657 cubic yards, by local authorities 283,923 cubic yards. Lost by abandonment during the year, 140,385 cubic yards. The grade of new work by the United States is from 2 feet to 2.9 feet above highest water.

Barataria Levee district, right bank (957 to 1,060 miles below Cairo).—This district extends from New Orleans to the Head of the Passes. The line is continuous to the Jump, 71.5 miles. The total yardage on May 1, 1897, was 2,098,008 cubic yards, to which was added during the year by the United States 78,359 cubic yards, by local authorities 203,446 cubic yards. None lost by abandonment. The grade of new United States work is from 1.9 feet to 2.6 feet above highest water.

Homochitto Levee district, left bank (594 to 833 miles below Cairo).—There are as yet no levees in this district except a few detached pieces built by private parties.

Pontchartrain Levee district, left bank (833 to 957 miles below Cairo).—This district extends from Baton Rouge to New Orleans. The line is continuous. The total yardage on May 1, 1897, was 11,137,516 cubic yards, of which the United States built 75 per cent. There were added during the year to May 1, 1898, by the United States 472,850 cubic yards, by local authorities 372,192 cubic yards. Lost by abandonment during the year, 20,604 cubic yards. The grade of the new work is, most of it, from 3.1 feet to 3.9 feet above highest water.

Lake Borgne Levee district, left bank (965 to 1,060 miles below Cairo).—The district extends from New Orleans to the Head of the Passes. The line is continuous to Fort St. Philip, 70 miles. The total yardage on May 1, 1897, was 2,485,215 cubic yards, of which the United States built 65 per cent. During the year to May 1, 1898, there were added by the United States 91,402 cubic yards, by local authorities 59,305 cubic yards. None was lost by abandonment. The grades of the new work are from 2.5 feet to 2.9 feet above highest water.

STAGES OF THE RIVER.

The lowest water of the season at Cairo occurred from October 21 to 28, 1897, when the gauge showed 2.5 feet above zero. It marked 3 feet or less from October 8 to November 10.

Since the beginning of this calendar year there have been two floods, one culminating at Cairo, January 31, when the gauge read 44.3 feet above zero, the river being at 40 feet or above between January 23 and February 6. The second flood culminated at Cairo on April 6, the water reaching 49.8 feet above zero and being 40 feet or above between March 24 and April 17. These floods caused no breaks in the levees, though interfering much with work and necessitating considerable expense in watching and maintaining the lines. The April flood was 1.9 feet lower than the 1897 flood at Cairo, but was higher at Fulton, Tenn., by 0.8 feet, and in the vicinity of Lake Providence higher by 0.3 feet, the increased height being due to the closure of crevasses. The flood slopes of 1898, being unaffected by outflows from the river from Helena to the Gulf, with the exception of the crevasses aggregating 6,500 feet in length in White River front, and the Atchafalaya outlet, give additional valuable information for the final determination of levee heights.

This is the first time in the history of the river since the commencement of the continuous levee system that a flood reaching the height of 49.8 feet on the gauge at Cairo has been carried to the Gulf without a single break in the levees.

Respectfully submitted.

G. L. GILLESPIE,
Colonel, Corps of Engineers, U. S. A.,
Brigadier-General, United States Volunteers,
President Mississippi River Commission.
B. M. HARROD.
ROBERT S. TAYLOR.
HENRY FLAD.
AMOS STICKNEY,
Lieutenant-Colonel of Engineers, U. S. A.
THOS. H. HANDBURY,
Major, Corps of Engineers, U. S. A.
HENRY L. MARINDIN,
Assistant, United States Coast and Geodetic Survey.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

Money statement.

Appropriations expended under Mississippi River Commission.

July 1, 1897, balance unexpended		$3,896,469.17
Amount appropriated by act of July 19, 1897		625,000.00
Amounts received from refundments of overpayments		10.44
		4,521,479.61
June 30, 1898, amount expended during fiscal year		2,536,786.09
July 1, 1898, balance unexpended		1,984,693.52
July 1, 1898, outstanding liabilities	$199,833.30	
July 1, 1898, amount covered by uncompleted contracts	1,023,272.72	
		1,223,106.02
July 1, 1898, balance available		761,587.50
Distributed as follows:		
Mississippi River Commission		3,000.00
Surveys, gauges, and observations		7,683.45
Levees		165,790.22
Revetment and contraction works and permanent channel improvements		17,158.47
Dredges and dredging		180,000.00
Plant and miscellaneous		23,595.10
Improving harbors and tributaries		332,176.26
Works above Cairo		8,561.00
Unallotted		23,623.00
Total		761,587.50

Amounts necessary to be appropriated for the fiscal year ending June 30, 1900.

For improving Mississippi River from Head of the Passes to mouth of the Ohio River	$2,583,333.00
For improving harbor at—	
Greenville, Miss	50,000.00
Delta Point, La	110,000.00
Natchez, Miss., and Vidalia, La	300,000.00
New Orleans, La	400,000.00
For improvement at head of Atchafalaya River and mouth of Red River, Louisiana	25,000.00

Consolidated statement of condition of appropriations and allotments, under Mississippi River Commission, on June 30, 1898.

[Appropriation: Improving Mississippi River.]

	Secretary Mississippi River Commission.				
	Mississippi River Commission.	Surveys, gauges, and observations.	Dredges and dredging.	Patrol of the Mississippi River.	Total.
Amount expended on previous projects	$238,110.74	$855,247.37	....	....	$1,093,358.11
Amount expended on present project to end of last fiscal year	234,375.40	486,788.84	a$317,047.21	$463.52	1,038,674.97
Balance unexpended at end of last fiscal year	10,624.60	25,936.49	136,089.27	9,536.48	182,186.84
Amount expended from beginning of present fiscal year to end of previous month	b 29,270.91	c 72,594.14	d 464,943.29	592.04	567,400.38
Amount expended during the month	e 2,134.45	6,133.99	f 18,291.14	....	26,559.58
Balance unexpended at end of month	17,219.24	14,918.36	g 669,612.66	....	701,750.26
In Treasury United States	10,683.56	11,000.00	619,455.49	....	641,139.05
In hand	6,535.68	3,918.36	50,157.17	....	60,611.21
Total	17,219.24	14,918.36	669,612.66	....	701,750.26
Outstanding liabilities at end of month	11,479.24	10,918.36	158,056.14	....	180,453.74
Amount covered by existing contracts at end of month	2,740.00	....	331,556.52	....	334,296.52
Total	14,219.24	10,918.36	489,612.66	....	514,750.26
Balance available at end of month	3,000.00	4,000.00	180,000.00	....	187,000.00

	Works above Cairo.		
	h Protection near Cairo.	Des Moines Rapids to Ohio River.	Total.
Amount expended on previous projects	....	....	....
Amount expended on present project to end of last fiscal year	$41,400.00	$687,632.53	$729,032.53
Balance unexpended at end of last fiscal year	8,600.00	....	8,600.00
Amount expended from beginning of present fiscal year to end of previous month	....	....	....
Amount expended during the month	....	....	....
Balance unexpended at end of month	8,600.00	....	8,600.00
In Treasury United States	....	....	....
In hand	8,600.00	....	8,600.00
Total	8,600.00	....	8,600.00
Outstanding liabilities at end of month	39.00	....	39.00
Amount covered by existing contracts at end of month	....	....	....
Total	39.00	....	39.00
Balance available at end of month	8,561.00	....	8,561.00

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[a] Does not include $388,097.12 expended by officer in charge of First and Second districts; $1,964.81 expended by officer in charge of Fourth district.

[b] Increased 92 cents Treasury settlement that should have been dropped in November, 1897 (see footnotes to statement for that month).

[c] Increased $4.70 Treasury settlement that should have been dropped in November, 1897 (see footnotes to statement for that month).

[d] Increased 93 cents Treasury settlement that should have been dropped in November, 1897 (see footnotes to statement for that month).

[e] Includes 20 cents on Treasury settlement No. 4894, with Pennsylvania Railroad Company, for passenger transportation; $1.15 on Treasury settlement No. 4910, $2.92 on Treasury settlement No. 4944, $1.67 on Treasury settlement No. 5019, with Western Union Telegraph Company, for telegrams; $20.50 on Treasury settlement No. 5055, with Baltimore and Ohio Southwestern Railway Company, for passenger transportation; total $26.44.

[f] Includes $1.39 on Treasury settlement No. 4944, 94 cents on Treasury settlement No. 5019, with Western Union Telegraph Company, for telegrams; total $2.33.

[g] Includes $9,457.82 transferred back from "Dredges and dredging," Fourth district, by president Mississippi River Commission, June 18, 1898, approved by Secretary of War, June 24, 1898.

[h] Includes only work under act of July 3, 1884.

Consolidated statement of condition of appropriations and allotments, under Mississippi River Commission, on June 30, 1898—Continued.

FIRST AND SECOND DISTRICTS.

[Appropriations: Improving Mississippi River; improving harbor at Memphis, Tenn.]

	Surveys, gauges, and observations.	Lower St. Francis Levee district.	White River Levee district.	Upper Yazoo Levee district.	Plum Point Reach.
Amount expended on previous projects					
Amount expended on present project to end of last fiscal year	$91, 247. 66	$354, 697. 34	$902, 757. 35	$811, 619. 92	$4, 868, 656. 19
Balance unexpended at end of last fiscal year	2, 925. 45	8, 942. 16	4, 489. 75	16, 606. 86	4. 43
Amount expended from beginning of present fiscal year to end of previous month	2, 250. 03	76, 118. 14	125, 022. 89	59, 729. 15	*a* 4. 43
Amount expended during the month		110. 62	463. 65	5, 560. 57	
Balance unexpended at end of month	675. 42	4, 700. 90	15, 740. 71	32, 442. 14	
In Treasury United States		50. 00	5, 299. 70	31, 500. 00	
In hand	675. 42	4, 650. 90	10, 441. 01	942. 14	
Total	675. 42	4, 700. 90	15, 740. 71	32, 442. 14	
Outstanding liabilities at end of month		210. 00	300. 00	300. 00	
Amount covered by existing contracts at end of month			13, 282. 17	28, 000. 00	
Total		210. 00	13, 582. 17	28, 300. 00	
Balance available at end of month	675. 42	4, 490. 90	2, 158. 54	4, 142. 14	

	Plant.	Removal Nonconnah Rock.	Preservation of works at Hopefield Bend.	Preservation of works at Walnut Bend Levee.	Preservation of works.
Amount expended on previous projects					
Amount expended on present project to end of last fiscal year	$646, 281. 10	$5, 999. 26			$54, 845. 30
Balance unexpended at end of last fiscal year	34, 418. 88	. 74			22. 59
Amount expended from beginning of present fiscal year to end of previous month	60, 584. 49	. 74	$13, 354. 27	$14, 275. 52	1. 62
Amount expended during the month	2, 976. 38			2, 405. 79	
Balance unexpended at end of month	10, 858. 01		6, 645. 73	13, 318. 69	20. 97
In Treasury United States	6, 990. 00			5, 000. 00	12. 28
In hand	3, 868. 01		6, 645. 73	8, 318. 69	8. 69
Total	10, 858. 01		6, 645. 73	13, 318. 69	20. 97
Outstanding liabilities at end of month	3, 500. 00			250. 00	
Amount covered by existing contracts at end of month				12, 000. 00	
Total	3, 500. 00			12, 250. 00	
Balance available at end of month	7, 358. 01		6, 645. 73	1, 068. 69	20. 97

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a Includes 20 cents on Treasury settlement No. 2488, with Western Union Telegraph Company, deposited to credit of Treasurer of United States, October 11, 1897, and not heretofore dropped.

Consolidated statement of condition of appropriations and allotments, under Mississippi River Commission, on June 30, 1898—Continued.

FIRST AND SECOND DISTRICTS—Continued.

[Appropriations: Improving Mississippi River; improving harbor at Memphis, Tenn.]

	At New Madrid, Mo.	At Helena. Ark.	Improving harbor at Memphis, Tenn.	Improving harbor at Memphis, Tenn. (Wolf River).	Expended allotments.	Total.
Amount expended on previous projects	....	....	....	....	....	....
Amount expended on present project to end of last fiscal year	$60,827.02	$130,462.83	$1,418,679.82	$10,000.00	[a] $595,979.12	$9,952,052.91
Balance unexpended at end of last fiscal year	1,172.98	10,037.17	6,358.95	35,000.00	....	119,979.96
Amount expended from beginning of present fiscal year to end of previous month	....	8.80	3,697.56	4,275.62	....	359,323.26
Amount expended during the month	....	....	....	....	....	11,517.01
Balance unexpended at end of month	1,172.98	10,028.37	2,661.39	30,724.38	....	128,989.69
In Treasury United States	....	....	....	23,000.00	....	71,851.98
In hand	1,172.98	10,028.37	2,661.39	7,724.38	....	57,137.71
Total	1,172.98	10,028.37	2,661.39	30,724.38	....	128,989.69
Outstanding liabilities at end of month	....	....	....	....	....	4,560.00
Amount covered by existing contracts at end of month	....	....	....	8,000.00	....	61,282.17
Total	....	....	....	8,000.00	....	65,842.17
Balance available at end of month	1,172.98	10,028.37	2,661.39	22,724.38	....	63,147.52

[a] Columbus, Ky., $43,750; Hickman, Ky., $89,132; improving St. Francis River, $75,000; dredges and dredging, $388,097.12.

THIRD DISTRICT.

[Appropriations: Improving Mississippi River; improving harbor at Vicksburg, Miss.]

	Surveys, gauges, and observations.	Lower Yazoo Levee district.	Upper Tensas Levee district.	Ashbrook Neck.	At Greenville, Miss.	Lake Providence, Reach.
Amount expended on previous projects	....	....	....	....	....	....
Amount expended on present project to end of last fiscal year	$68,315.68	$1,468,638.75	$3,108,731.78	$129,993.78	$603,616.33	$3,520,841.39
Balance unexpended at end of last fiscal year	4,613.64	78,303.64	111,176.02	11,010.09	47,026.69	4,481.91
Amount expended from beginning of present fiscal year to end of previous month	4,187.98	579,153.52	284,849.26	12,277.48	95,061.12	4,837.67
Amount expended during the month	177.25	18,344.10	10,046.75	....	....	....
Balance unexpended at end of month	248.41	142,106.02	179,430.01	7,677.05	1,965.57	[a] 4,394.24

[a] Decreased $10,000, transferred to "Improving harbor of New Orleans, La.," by resolution Mississippi River Commission, June 17, 1898; approved by Secretary of War June 27, 1898.

Consolidated statement of condition of appropriations and allotments, under Mississippi River Commission, on June 30, 1898—Continued.

THIRD DISTRICT—Continued.

	Surveys, gauges, and observations.	Lower Yazoo Levee district.	Upper Tensas Levee district.	Ashbrook Neck.	At Greenville, Miss.	Lake Providence, Reach.
In Treasury United States	....	$116,300.00	$146,400.00	....	....	....
In hand	$248.41	25,806.02	33,030.01	$7,677.05	$1,965.57	*a* $5,644.24
Total	248.41	142,106.02	179,430.01	7,677.05	1,965.57	5,644.24
Outstanding liabilities at end of month	200.00	2,500.00	2,500.00	....	....	....
Amount covered by existing contracts at end of month	....	139,606.02	153,600.00	....	....	....
Total	200.00	142,106.02	156,100.00	....	....	....
Balance available at end of month	48.41	....	23,330.01	7,677.05	1,965.57	4,394.24

	Delta Point, La.	Stone.	Plant.	Improving harbor at Vicksburg, Miss.	Expended allotments.	Total.
Amount expended on previous projects	....	....	....	....	....	....
Amount expended on present project to end of last fiscal year	....	$144,968.30	$593,626.27	$580,008.95	*b* $145,358.04	$10,673,099.27
Balance unexpended at end of last fiscal year	....	15,031.70	35.44	2,972.03	....	274,651.16
Amount expended from beginning of present fiscal year to end of previous month	$3,254.28	20,439.11	23,678.18	2,972.03	....	1,080,710.63
Amount expended during the month	....	15,505.41	2,378.51	....	....	46,452.02
Balance unexpended at end of month	2,745.72	9,087.18	48,978.75	....	....	396,632.95
In Treasury United States	....	6,000.00	45,000.00	....	....	313,700.00
In hand	2,745.72	3,087.18	3,978.75	....	....	84,182.95
Total	2,745.72	9,087.18	48,978.75	....	....	397,882.95
Outstanding liabilities at end of month	....	4,000.00	3,000.00	....	....	12,200.00
Amount covered by existing contracts at end of month	....	....	37,450.00	....	....	330,656.02
Total	....	4,000.00	40,450.00	....	....	342,856.02
Balance available at end of month	2,745.72	5,087.18	8,528.75	....	....	53,776.93

a $1,250 of this amount pertains to allotment for "Improving harbor of New Orleans, La.," to be transferred to officer in charge Fourth district.

b Lake Bolivar front, $145,358.04.

Consolidated statement of condition of appropriations and allotments, under Mississippi River Commission, on June 30, 1898—Continued.

FOURTH DISTRICT.

[Appropriations: Improving Mississippi River; improving harbor of Natchez, Miss., and Vidalia, La.; improving harbor of New Orleans, La.; improving Atchafalaya and Red rivers, Louisiana.]

	Surveys, gauges, and observations.	Lower Tensas Levee district.	Atchafalaya Levee district.	Lafourche Levee district.	Barataria Levee district.
Amount expended on previous projects	....	....	....	....	....
Amount expended on present project to end of last fiscal year	$76,496.81	$1,664,912.01	$1,017,584.66	$399,051.25	$228,386.31
Balance unexpended at end of last fiscal year	3,140.33	34,136.93	....	6,345.17	17,309.06
Amount expended from beginning of present fiscal year to end of previous month	657.81	165,417.49	57,970.90	11,670.70	19,349.70
Amount expended during the month	23.40	7,737.53	918.78	631.92	97.33
Balance unexpended at end of month	2,959.62	134,681.91	107,835.32	44,080.05	21,199.53
In Treasury United States	1,000.00	134,681.91	86,600.00	23,600.00	10,900.00
In hand	1,959.62	....	21,235.32	20,480.05	10,299.53
Total	2,959.62	134,681.91	107,835.32	44,080.05	21,199.53
Outstanding liabilities at end of month	....	233.00	522.09	166.50	42.50
Amount covered by existing contracts at end of month	....	67,353.49	86,123.39	27,501.75	14,399.87
Total	....	67,586.49	86,645.48	27,668.25	14,442.37
Balance available at end of month	2,959.62	67,095.42	21,189.84	16,411.80	6,757.16

	Pontchartrain Levee district.	Lake Borgne Levee district.	Dredges and dredging.	Plant.	Preservation of works.
Amount expended on previous projects	....	....	....	....	....
Amount expended on present project to end of last fiscal year	$784,098.77	$190,957.83	$1,964.81	....	$109,923.64
Balance unexpended at end of last fiscal year	2,985.71	14,337.30	....	$10,000.00	24,076.36
Amount expended from beginning of present fiscal year to end of previous month	65,823.59	18,379.17	542.18	10,410.56	24,076.36
Amount expended during the month	61.90	293.07	....	1,397.56	....
Balance unexpended at end of month	73,250.22	22,365.06	(*a*)	18,191.88	....
In Treasury United States	48,650.00	8,700.00	....	5,000.00	....
In hand	24,600.22	13,665.06	....	13,191.88	....
Total	73,250.22	22,365.06	....	18,191.88	....
Outstanding liabilities at end of month	263.58	42.44	....	483.54	....
Amount covered by existing contracts at end of month	66,090.61	10,093.90	....	10,000.00	....
Total	66,354.19	10,136.34	....	10,483.54	....
Balance available at end of month	6,896.03	12,228.72	....	7,708.34	....

a Decreased $9,457.82, transferred to "Dredges and dredging," secretary's office, by president Mississippi River Commission, June 18, 1898; approved by Secretary of War June 24, 1898.

Consolidated statement of condition of appropriations and allotments, under Mississippi River Commission, on June 30, 1898—Continued.

FOURTH DISTRICT—Continued.

[Appropriations: Improving Mississippi River; improving harbor of Natchez, Miss., and Vidalia, La., improving harbor of New Orleans, La.; improving Atchafalaya and Red rivers, Louisiana.]

	Improving harbor of Natchez and Vidalia, Miss. and La.	Improving harbor of New Orleans, La.	Improving Atchafalaya and Red rivers, Louisiana.	Total.
Amount expended on previous projects	....	....	....	....
Amount expended on present project to end of last fiscal year	$122,722.87	$780,482.56	$893,748.08	$6,270,723.60
Balance unexpended at end of last fiscal year	109,529.17	57,907.30	82,961.32	862,728.65
Amount expended from beginning of present fiscal year to end of previous month	84,494.13	6,219.13	14,454.60	478,965.82
Amount expended during the month	3,090.74	436.31	1,168.85	15,857.39
Balance unexpended at end of month	a 131,944.30	b 101,251.86	67,337.87	725,097.62
In Treasury United States	126,500.00	93,750.00	65,500.00	604,881.91
In hand	5,444.30	c 6,251.86	1,837.87	118,965.71
Total	131,944.30	100,001.86	67,337.87	723,847.62
Outstanding liabilities at end of month	486.13	240.20	100.58	2,580.56
Amount covered by existing contracts at end of month	2,500.00	10,475.00	2,500.00	297,038.01
Total	2,986.13	10,715.20	2,600.58	299,618.57
Balance available at end of month	128,958.17	90,536.66	64,737.29	425,479.05

a Decreased $40,000, transferred to "Improving harbor of New Orleans, La.," by resolution Mississippi River Commission, June 17, 1898; approved by Secretary of War June 27, 1898.

b Includes $50,000 transferred ($40,000 from "Improving harbor of Natchez and Vidalia, Miss. and La.," and $10,000 from "Lake Providence Reach") by resolution Mississippi River Commission, June 17, 1898; approved by Secretary of War June 27, 1898.

c Does not include $1,250 in hands of officer in charge Third district under allotment for "Lake Providence Reach," to be transferred to officer in charge Fourth district.

Consolidated statement of all appropriations expended under the Mississippi River Commission, to June 30, 1898.

Act of June 28, 1879		$175,000.00
Act of June 16, 1880		150,000.00
Act of March 3, 1881		1,000,000.00
Act of March 3, 1881		150,000.00
Act of August 2, 1882		4,123,000.00
Act of August 7, 1882		150,000.00
Act of March 3, 1883		150,000.00
Act of January 19, 1884		1,000,000.00
Act of July 5, 1884		75,000.00
Act of July 5, 1884, less $5,000 transferred to snag-boat service		2,065,000.00
Act of July 7, 1884		75,000.00
Act of August 5, 1886, less $5,942.60 for expenses office Chief of Engineers		1,994,057.40
Act of August 5, 1886, less $47.30 for expenses office Chief of Engineers		29,952.70
Act of August 11, 1888, less $4,859 for expenses office Chief of Engineers		2,840,141.00
Act of August 11, 1888		75,000.00
Act of October 2, 1888		35,000.00
Act of October 19, 1888 (deficiency), less $4,214.39 reverted to the Treasury		20,785.61
Act of September 19, 1890		3,200,000.00
Act of September 30, 1890 (deficiency)		5,625.00
Act of March 3, 1891 (deficiency)		1,950.00
Act of March 3, 1891		1,000,000.00
Act of July 13, 1892		2,470,000.00
Act of July 28, 1892 (deficiency)		44.80
Act of March 3, 1893		2,665,000.00
Act of August 17, 1894		485,000.00
Act of August 18, 1894		2,665,000.00
Act of March 2, 1895		2,665,000.00
Act of June 3, 1896		909,000.00
Joint resolution approved March 31, 1897 (Public—No. 6)		250,000.00
Act of June 4, 1897		2,933,333.00
Act of June 19, 1897 (deficiency)		625,000.00
Total specific appropriations		83,982,889.51
Balances from former appropriations applied to works below Cairo, under act of August 2, 1882, less $123.42, reverted to Treasury	$272,504.96	
Same for works above Cairo, under act of July 5, 1884	22,632.53	
Total balances		295,137.49
Total		84,278,027.00

Consolidated statement of all appropriations expended under the Mississippi River Commission, to June 30, 1898.—Continued.

EXPENDED.

Location and object.	To June 30, 1897.	During year ending June 30, 1898.	Total.
Mississippi River Commission	$472,486.14	$31,405.36	$503,891.50
Surveys, gauges, and observations	[a]1,578,096.36	86,024.10	1,664,120.46
Levees	11,059,246.02	1,548,010.02	12,607,256.04
Revetment and contraction works and permanent channel improvements	9,161,775.85	53,064.84	9,214,840.69
Dredges and dredging	[b]707,109.14	483,770.61	1,190,885.75
Plant and miscellaneous	[c]1,240,370.89	102,017.72	1,342,388.61
Improving harbors and tributaries	4,808,430.46	232,487.44	5,040,917.90
Works above Cairo	729,032.53	....	729,032.53
Total expended	29,756,547.39	2,536,786.09	32,293,333.48
Balance unexpended June 30, 1898	....	....	1,961,070.52
Unallotted June 30, 1898	....	....	23,623.00
Total appropriated	....	....	34,278,027.00

[a] Amount formerly reported reduced 42 cents on account of overpayments refunded.
[b] Amount formerly reported reduced 2 cents on account of overpayments refunded.
[c] Amount formerly reported reduced $10 on account of overpayments refunded.

LIST OF APPENDICES ACCOMPANYING REPORT OF MISSISSIPPI RIVER COMMISSION FOR THE FISCAL YEAR ENDING JUNE 30, 1898.

Appendix 1.

Report of Capt. H. E. Waterman, Corps of Engineers, secretary Mississippi River Commission (82 plates).

Appendix 2.

Report of Capt. Mason M. Patrick, Corps of Engineers, upon operations in the First and Second districts (17 plates).

Appendix 3.

Report of Capt. H. C. Newcomer, Corps of Engineers, upon operations in the Third district (8 plates).

Appendix 4.

Report of Capt. George McC. Derby, Corps of Engineers, upon operations in the Fourth district (5 plates).

APPENDIX 1.

REPORT OF CAPT. H. E. WATERMAN, CORPS OF ENGINEERS, SECRETARY MISSISSIPPI RIVER COMMISSION.

MISSISSIPPI RIVER COMMISSION, OFFICE OF THE SECRETARY,
St. Louis, Mo., May 31, 1898.

COLONEL: I have the honor to submit the following annual report of operations under this office for the year ending May 31, 1898.

The work in charge of the secretary Mississippi River Commission during the past year has been carried on under allotments made by the Mississippi River Commission from the appropriations for improving Mississippi River between the Head of the Passes and the mouth of the Ohio, contained in the sundry civil bill approved June 4, 1897, together with available balances from allotments from previous appropriations.

These allotments are as follows:

(*1*) *Mississippi River Commission.*—Available for salaries, clerical, office, and miscellaneous expenses of the Mississippi River Commission.

(*2*) *Surveys, gauges, and observations.*—Available for the survey of the Mississippi River between the Head of the Passes and its head waters, for the establishment and maintenance of gauges, for special surveys and examinations, and for the collection and reduction of physical data pertaining to the Mississippi River.

(*3*) *Dredges and dredging.*—Available for the construction and operation of dredges for the Mississippi River between Cairo, Ill., and the Head of the Passes.

(*4*) *Patrol of the Mississippi River.*—Available for patrolling of the Mississippi River in time of flood for the saving of life and property. This was an emergency allotment made by the Mississippi River Commission at its sixty-ninth session, March 24, 1897, to cover expenses incurred in the extraordinary flood of 1897. The balance unexpended at close of last fiscal year ($8,944.44) has all been expended during the present one by transfer to the allotment for Ashbrook Neck under Third district, improving Mississippi River, in accordance with resolution of Mississippi River Commission adopted June 26, 1897.

MISSISSIPPI RIVER COMMISSION.

The Mississippi River Commission has held three sessions during the past year, as follows:

Seventieth session, June 24–26, 1897, at Army Building, New York City.

Seventy-first session, July 22, 1897, at Army Building, New York City.

Seventy-second session, February 2–7, 1898, St. Louis, Mo., office Mississippi River Commission, and on steamer *Mississippi*, St. Louis, Mo., to New Orleans, La.

The usual fall inspection trip of the river last year was omitted on account of the prevalence of yellow fever along the lower river, and the spring trip was held earlier than usual in order to suit the convenience of the subcommittee of the Senate Committee on Commerce, who desired to inspect the Lower Mississippi River in company with the commission.

The various committees of the commission have held the following special meetings since my last annual report:

Committee on dredges, November 12–13, 1897, on steamer *Minnetonka*, Cairo, Ill., to Memphis, Tenn.; December 14, 1897, and February 1, 1898, at St. Louis, Mo.

At the date of last year's report the steamer *Mississippi* was laid up at St. Louis, Mo. On June 3 she was put in commission to be used as a tender for dredges and transferred to the allotment for dredges and dredging. On August 20 she was put out of commission at St. Louis, Mo., and on September 3 was again transferred to dredges and dredging for use as a tender to the dredge *Alpha*. At the close of January, 1898, she was relieved as a tender to the dredges and ordered to St. Louis to prepare for the usual spring inspection trip. It was expected that the commission, accompanied by the Senate Subcommittee on Commerce, would leave St. Louis on the morning of February 3, 1898, but owing to a cold wave and ice, which threatened to close the river, the steamer was ordered to Cairo on Tuesday, February 1, arriving the following day. The commission and Senate subcommittee proceeded by rail from St. Louis to Cairo, boarding the steamer at the latter point on February 3. New Orleans was reached on February 8 and the steamer returned to St. Louis, arriving on February 21. The boat was laid up at the Vulcan Iron Works, Carondelet, for extensive repairs, the boilers, especially, being found, on inspection, entirely worn out. Proposals for new boilers were opened April 2, 1898, and contract for the same awarded to John O'Brien Boiler Works Company, of St. Louis, Mo., April 15, for the sum of $2,740. Various other repairs to the machinery and plumbing, including the installation of a distilling plant, have been made.

SURVEYS, GAUGES, AND OBSERVATIONS.

A complete history of the work of this character conducted by the Mississippi River Commission and its predecessors prior to May 25, 1896, will be found in the Annual Report of the Chief of Engineers for 1896, in Part VI, pages 3575, 3576.

Survey of the Mississippi River.—This survey, which is directed by law to extend from the Head of the Passes to the head waters of the river, has been made with a view of obtaining sufficient data for accurate topographical and hydrographical maps, which may be used in studying the physical characteristics of the river and in planning improvements, and which may also serve as a basis for future surveys by which means the changes in the bed and banks may be ascertained and their causes and effects studied. It has, therefore, been carried on in a most thorough manner, using only the most approved methods. The field work consists of secondary triangulation, precise levels, topography, and hydrography. The limits of error allowed for the secondary triangulation compare favorably with those ordinarily established for primary work. The methods used on this survey are fully explained in the Annual Report of the Chief of Engineers, United States Army, for 1891. Part VI, pages 3474–3485.

At the close of May, 1897, the following was the status of the work on this survey:

Secondary triangulation.—This work had been completed from the mouth of the river to Minneapolis, Minn., a distance of 1,992 miles. About 400 miles of this work was done under the direction of the Engineer Department, United States Army, and by the Coast and Geodetic Survey prior to the creation of the Mississippi River Commission.

Precise levels.—This work had been completed from the Gulf end of East Jetty at the mouth of South Pass to St. Paul, Minn., a distance of 1,982 miles, with side lines, Biloxi, Miss., to Carrollton, La., 87 miles; Savanna, Ill., to Chicago, Ill., 148 miles, and St. Paul, Minn., to Duluth, Minn., 156 miles, making a grand total of 2,373 miles. Some 479 miles of this line between Carrollton, La., and Greenville, Miss., were run by the Coast and Geodetic Survey.

Topography and hydrography.—This work had been completed to near Brownsville, Minn., 751 miles above Cairo.

During the summer of 1897 the field work of topography and hydrography was extended from Brownsville, northward, to St. Paul, which was reached on November 16, 1897.

The survey of this season has been unusually tedious, owing to the intricate maze of sloughs covering the greater part of the area lying between the bluffs, and on account of the many important cities included within the same limits, and the mapping of which calls for the determination of a large number of locations.

The field work is now completed to the upper limits of Fort Snelling Reservation, about 7 miles above the steamboat landing at St. Paul.

The field work of the past season may be summarized as follows:

Main River survey (channel distance)	miles..	175
Topography	square miles..	500
Hydrography	do....	84.5

At the close of this work the plant and a portion of the crew were transferred to the lower river for use on the low-water survey, and the surveyors were transferred to this office for the reduction and platting of the field notes.

An extension of the survey of the Mississippi River beyond St. Paul, Minn., has been authorized and preparations are being made to begin the secondary triangulation and precise-level work about June 1, next. A small reconnoitering party is already in the field locating positions for the triangulation stations.

Special surveys.—During the year 1894 low-water surveys from the mouth of the Arkansas River, southward, were begun for the purpose of determining, by comparison with earlier surveys the effect, if any, of the levees on the low-water bed of the Mississippi River. The first surveys were made from the mouth of the Arkansas River to Vicksburg in 1894, but in 1895-96 they were extended to Donaldsonville, La. The lower portion of the river having been covered at a stage differing considerably from that existing at the time of the surveys of 1882-83, with which the later surveys were to be compared, it was recommended that that part between Scot Bluff (828) and Carrollton, La., (957) should be resurveyed. This resurvey was completed in December, 1897, and January, 1898. The indications from the surveys of 1896 made after two seasons of unusually low water were that in this section of the river a slight filling up of the bed had occurred since 1882. The indications from this resurvey, however, are that the former filling up has been practically entirely removed by the great flood of 1897. These low-water surveys indicate, on the whole, that the low-water bed has deepened between the levee lines, but the amount is so small that it is not at all certain but it may be due to the difference in the stage conditions of the two surveys under comparison.

The line of precise levels which was run between New Orleans and the end of the East Jetties in 1892-93 showed that the lower end of the Delta of the Mississippi was subsiding. A discussion of these results will be found in the Report of the Chief of Engineers for 1896, pages 3478-3484. It was determined this year to relevel the line from the hills at Baton Rouge to the end of the jetties in order to determine, if possible, the rate of subsidence and the length of the Delta affected. A double precise-level party under Surveyor W. S. Williams was put in the field on December 6, 1897. Work was completed to the end of East Jetty on March 19, and the survey party and outfit returned to New Orleans on March 21, where they were detached for duty on the survey of the Southwest Pass at the request of the Board of Engineer Officers in charge of this survey. The results of this line of levels have not been fully worked up, but the preliminary computations indicate that such subsidence has been going on since 1892 at a measurable rate.

Gauges.—The permanent gauges of the Mississippi River (14 on the Mississippi, 1 on the St. Francis, and 1 on the White River) have been maintained throughout the year. Those on the main river have been inspected by a party on the steamer *Search* three different times during the past year.

Besides the above, a continuous tide gauge is maintained at Biloxi, Miss., which was inspected once during the past year. By the end of October, 1898, we will have a continuous record of three years' duration for this tide gauge The record has been an exceptionally good one, and will give all of the data necessary for deducing a close value for the elevation of mean Gulf level at this point.

In addition to the permanent gauges the high-water gauges at intervals of 5 miles, from Cairo to Fort Jackson, have been maintained, and careful observations on the same were taken during the present high water. These high-water gauges apparently give a much more accurate determination of the high-water plane throughout the entire length of the river than has ever been determined heretofore. During the past high water, at Fulton, Tenn., the stage reached was 0.8 foot higher than in 1897, though 1.9 feet lower at Cairo. In the vicinity of Lake Providence the stage was also higher than in 1897, the difference ranging from 0.0 to 0.3 foot. At all other points the stage of 1898 was lower than that of 1897, but when the final reports of the inspection of the gauges are received some corrections may be required to these figures. A profile is appended to the report, plate 3, showing the high waters of 1882, 1892, 1897, and 1898, and the low water of 1895.

Observations.—Continuous observations for ascertaining the discharge of the Mississippi River were carried on under the Commission in 1879 and 1880 at Columbus, Ky.; Fulton, Tenn., and Carrollton, La.—covering a period of three months at Columbus, one year at Fulton, and ten months at Carrollton; and during 1881 and 1882 a more extended series of observations was made at Columbus, Ky.; Helena, Ark.; Hays Landing, Miss.; Red River Landing, La., and Paducah, Ky. Again, in 1884 and 1885 an extended series of observations was made at Point Pleasant Mo.; Helena, Ark.; Arkansas City, Ark.; Warrenton, Miss.; Red River Landing, La., and Carrollton, La. Parties were also maintained above Cairo at Prescott, Ark.; Winona, Minn.; Clayton, Iowa; Hannibal, Mo.; Grafton, Ill., and St. Louis, Mo., being engaged continuously on discharge work for about a year. Since this time a large number of observations have been made at various points during extreme high and low water stages. It has been intended to resume the continuous observations at various points on the lower river, but lack of funds has prevented the carrying out of these plans, and during the past year the only work of this kind has been the discharge measurements at or near high and low water at Columbus, Ky.; Helena, Ark.; Arkansas City, Ark.; Warrenton, Miss.; Red River Landing, La., and Carrollton, La., and on the tributaries at or near their mouth. The high-water discharge measurements are not taken unless an overflow stage is reached. These latter discharge observations were taken by a single party on the steamer *Search*, which performed these duties in addition to those of gauge inspection. No difficulty is experienced in obtaining the low-water discharges at or near the lower stage, but it has been found, particularly in the case of Helena, that, due to the slow rise, it is almost impossible with one party to secure discharges at the highest stage at this point without somewhat missing it below. In case it is deemed necessary to have the discharges at the highest stage throughout the river it will probably be advisable to obtain the discharges at Helena by a separate party.

Computation and reduction of field notes.—Considerable progress has been made on reducing and platting of field notes between St. Paul and Brownsville. This section of the river is covered by 33 field plats, of which 12 are entirely completed and the remainder are about nine-tenths completed. All low-water discharge measurements of 1897 and high-water measurements of 1898 have been reduced and tabulated. The current gauge records have also been corrected and monthly reports issued.

Plant and outfit.—The steamer *Patrol*, survey boat *Illinois*, and fuel barge and plant belonging to the same have been in use on the survey between Brownsville and St. Paul and on the low-water survey between Scot Bluff and Carrollton. The *Patrol* and fuel barge between March 22 and April 23, 1898, were loaned for the survey of the Southwest Pass to the Board of Engineer Officers in charge of the same. On April 23, 1898, the survey boat *Illinois* and outfit were loaned to the same Board to be used as quarters for the discharge party stationed at the Head of the Passes, Louisiana. This boat is still in the hands of Maj. James B. Quinn, Corps of Engineers, U. S. A., disbursing officer of the said Board. The *Patrol* and fuel barge early in May returned to New Madrid, Mo., and were turned over to the dredging fleet for care and repairs. The steamer *Search* has been used throughout the year for discharge work, gauge inspection, and also for making surveys in connection with dredging. Minor repairs have been made to her hull and machinery and the boat has been repainted. All of the plant pertaining to surveys, gauges, and observations will require repairs during the coming season. The steamer *Search* will probably need to be docked. For the work beyond St. Paul none of this floating plant can be utilized on account of the Falls of St. Anthony, and a complete camp outfit has been purchased for use of the survey party.

Mapping and publication of maps and charts.—Charts 150, 151, 152, 153, 154, 155, 156, and 157, scale 1:20,000, covering the river from Davenport, Iowa, to Arnolds Landing, Ill., a distance of 82 miles, have been completed and published. Charts 158, 159, and 160 are also completed, and 161, 162, 163, and 164, extending to Glen Haven, Wis. (650 miles above Cairo), are about two-thirds done.

Inch-mile sheets 121, 122, 123, and 124, extending to a point 597 miles above Cairo, Ill., have been completed, sheets 121 and 122 having been published.

Three sheets of the Upper Alluvial Valley map have been completed, and progress has been made on sheet No. 4; two sheets have been published.

Full and complete details of the work of the past season under surveys, gauges, and observations, with tables showing the actual results and discussion of the same, will be found in the appended report of J. A. Ockerson, assistant engineer (Appendix 1 C), to which attention is invited.

DREDGES AND DREDGING.

Construction, alteration, and repairs to plant.—On the 20th of June, 1896, a project was adopted by the Mississippi River Commission for the obtaining and maintaining by means of dredges of a channel in the Mississippi River, below Cairo, with a width of 250 feet and depth of 9 feet throughout the year, except when the river is closed by ice. This project provided for the construction and operation of seven hydraulic dredges by June 30, 1900, and for the reservation of funds for the construction of two others if found necessary.

The construction of this necessary plant has involved a very important branch of the work in this office. In accordance with the above project six hydraulic dredges—the *Alpha*, *Beta*, *Gamma*, *Delta*, *Epsilon*, and *Zeta*—have been constructed and tested, and the plans for a seventh dredge issued. Plans and specifications for the necessary large and small tenders, pile sinkers, and other plant for the operation of the dredges have been completed and a portion of the same already purchased.

The rapid expansion of this plant has involved a very large increase in the designing and drafting work of this office and the progress has not been as rapid as it could be wished, but it has been felt throughout that every attempt should be made to have specifications and drawings complete before being issued, in order that all plant when finally obtained should be properly designed and thoroughly permanent in character. Such of the plant as has already been purchased which did not entirely meet these requirements has also had to be altered, and this has added not a little to the extra work of designing.

Dredge Alpha.—This dredge was the first of the fleet constructed by the Mississippi River Commission, and was designed originally as an experiment. Many modifications have been made from time to time in order to meet different features of the work; but she has been able to do good work in the field during each low-water season since 1895. Considerable trouble, however, was experienced with her pump runner in 1896, and early in 1897 it was determined that the main pump should be replaced by a new one better suited in design to the engine. The contract for the new pump was awarded to the Morris Machine Works, Baldwinsville, N. Y., and the machinery was completed on board ready for work by about the middle of last September. The engine was meantime put in thorough repair. Just about the time the dredge was ready for field work an epidemic of yellow fever caused her detention in quarantine at Cairo for a period of about a month; but thereafter to the close of the season the working of the new pump was very satisfactory. Tests will soon be made of this dredge with the measuring barge to determine her actual capacity as remodeled, and it is hoped the results of these tests will be available for publication in the present report. (See Appendix 1 F.)

Dredge Beta.—The extensive work on this dredge has been due largely to the failure on the part of the original contractor to carry out the Government specifications, especially in his exceeding the draft requirement of 4¼ feet by some 2 feet. At the close of last year negotiations were in progress between the United States and the contractor, Lindon W. Bates, by which he was to release all claims for further payments to the United States in consideration of the Government taking the dredge as it was and doing the remodeling with any funds pertaining to this contract in its possession. The final contract between the United States and Lindon W. Bates settling this question was executed on June 1; and the committee on dredges decided on very extensive alterations, some of which were entirely outside of those chargeable to the contractor. The principal alterations directed were as follows:

(1) The draft of the boat to be reduced to 4¼ feet by widening 9 feet on each side and by adding about 4 feet at the stern.

(2) The forward battery of boilers to be turned around so as to have a single stoke hole for all boilers.

(3) The discharge pipes to be placed on the bottom of the boat, instead of overhead.

(4) The mechanical agitators to be removed and to be replaced by suction heads with water-jet agitators, each to be driven by a pressure pump.

(5) The 6-drum hoist to be taken out and four single hoists substituted.

(6) The 3-drum hoist formerly used for lifting spud to be replaced by a steam lifting cylinder.

(7) A cabin to be built on boiler deck with full accommodations for a double crew.

(8) Other additional minor changes and additions to be made to the existing machinery.

Preparation of the detail plans and specifications was at once begun, and after advertisement the contract for widening of the hull was let to the Iowa Iron Works, Limited, on May 14, 1898, for the sum of $26,900, the work of widening to be done on the dredge while in the United States Government dry dock at Keokuk, Iowa. As soon as the ice in the upper river broke up the boat was towed to this point by the U. S. steamer *Minnetonka* and docked April 9, 1898. Very slow progress has as yet been made under this contract. At the close of May, 1898, the half deck at the rear of the boat had been removed and about one-half the rivet holes for the side extensions drilled. Most of the material, however, is now on hand, and it is hoped that the widening will be practically completed by the close of June.

In addition to the above, contracts have been made for the winding machinery, pressure pumps, electric-light plant, suction heads, spud hoist, capstans, and other special machinery needed for the alterations to this boat.

Work is also being done by a small force aboard the dredge, at Keokuk, in altering the piping, repairing the engines, etc.

It is probable that the cabin work on this dredge will have to be completed while in the field.

Dredge Gamma.—At the close of my last annual report the U. S. dredge *Gamma* had been delivered by the contractors, John S. George and Howard P. Eells, receivers of Bucyrus Steam Shovel and Dredge Company, South Milwaukee, Wis., and was undergoing her final tests. Some difficulty was experienced in the heating of the bearings, but the boat was finally accepted and was transferred to the dredge fleet at Cairo for work during the past season.

Though this dredge is the smallest in size of hull and cabin accommodations of any of the fleet she has proved practically in the field very efficient on account of her portability.

Dredge Delta.—At the close of June, 1897, the dredge *Delta* was about completed and ready for testing. The tests were completed about the middle of August, and though the boat was entirely successful in carrying out the contract provisions, it was quite evident that a mechanical agitator of this type would hardly prove serviceable in the Mississippi River. The boat during the low-water season of 1897 was continually in trouble from wearing of the sprocket chains and from the catching of tne agitator arms in drift which was met with in the river bottom. There was also considerable wear to the pump shaft and bearing. Our experience with the *Delta* and previous experience with the *Alpha* rather indicates that a double suction pump is preferable to a single one.

Dredges Epsilon and Zeta.—At the close of June, 1897, the construction of the *Epsilon* and *Zeta* by the Springfield Boiler and Manufacturing Company, at Springfield, Ill., was well under way. The cabin work, however, had only just begun. The piping and minor details were incomplete, though the machinery was all on board. The dredges were moved to Cairo November 22, 1897, in a nearly finished condition. Work was continued at this point until the beginning of January, 1898, when they were turned over to the Government for tests. The tests of these dredges, as heretofore explained, were considerably delayed on account of the unfavorable season of the year and from trouble with the large fly wheels at first used by the contractor. As a result of their failure at the first test these fly wheels were replaced by new ones 19 inches less in diameter, which have not only proved fully equal to the work of producing a uniform speed, but have also largely done away with the strain on the bearings due to overhanging fly wheels.

The *Zeta* differs from the *Epsilon* in the use of a mechanical agitator in place of a water-jet agitator. On account of the numerous breakdowns on this dredge, which did not amount to enough in time to cause a rejection, but did indicate her inferiority as a working machine, it was finally determined to add a water-jet agitator to this dredge in addition to the mechanical agitator, and the necessary machinery for the installation of such a water-jet agitator has been ordered from the Morris Machine Works, of Baldwinsville, N. Y. The installation of this additional plant is expected to be completed some time in July.

Pile sinkers.—During the past year one pile-sinker hull has been constructed, and a contract has been made with the Cincinnati Marine Railway Company, of Cincinnati, Ohio, for the construction of four more. The machinery for these pile sinkers is on hand, having been transferred to this office by the officer in charge of the first and second districts.

Small steam tenders.—During the past year one small steam tender, for dredge surveys, the *Vulcan*, has been constructed by the Iowa Iron Works, Limited. On account of the slow progress on this work, due largely to the delays of the plate mill, the boat was frozen in at Dubuque, Iowa, before completion. At the opening of navigation near the end of March, 1898, the *Vulcan* was brought to St. Louis, and on her trial trip averaged over 10 miles per hour up and down stream. Plans and specifications for three other small steam tenders of this same type were prepared and issued, and the contract for their construction has been awarded to M. A. Sweeney Company, Jeffersonville, Ind., delivery to be made September 10, 1898. At the close of May, 1898, the hull materials for these boats had not yet been delivered; some work, however, had been done on the engines.

Large steam tenders.—During the past year the designing of the large steam tenders for use with the dredges has been taken in hand, and the proposals for these boats have just been opened. Great delay in the preparation of the plans and specifications was experienced, due to the sudden death of the steamboat draftsman at work on the same and difficulty in securing the services of another expert competent for this work.

New dredge.—The designing of a new dredge, the seventh of the fleet, to be known as the *Iota*, was taken up during the past year, and preliminary plans and specifications for a self-propelling dredge were submitted to the commission for its approval. Unfortunately, the commission did not meet in November and considerable delay was experienced. These preliminary plans, in fact, were not approved until the seventy-second session, early in February, 1898, and the great pressure of other work in this office has prevented the completion of the details until the present time. It is expected that the specifications will be ready for advertisement, however, early in June.

Repairs to plant.—The *Minnetonka*, during the low-water season of 1897, was sunk by a snag and was afterwards raised and sent to St. Louis for repairs. She was pulled out on the Carondelet ways and the necessary repairs effected by hired labor. At the close of the year she is again at St. Louis repairing a cracked cylinder and renewing her guards and roof. It has also been found that entirely new boilers and chimney casing are required, and contracts for this work have been made with John Rohan & Son Boiler Works Company, of St. Louis, Mo. Some changes are also being made in the electric-light plant.

During the past year the supervision of the construction of and extensive repairs to all plant has been in charge of Assistant Engineer Thomas Middleton, and to his report, appended (Appendix 1 D), attention is invited for additional details relative to this subject. In his report will also be found a detailed description of the six dredges and of the tenders and pile sinkers built for use of the Mississippi River Commission in dredging operations below Cairo.

DREDGING OPERATIONS ON THE LOWER MISSISSIPPI BETWEEN CAIRO, ILL., AND THE HEAD OF THE PASSES, LOUISIANA.

These operations have included the care and repair of plant in the field, the testing of new dredges, and the operation of plant in the field during the past low-water season.

All operations have been under the supervision of Assistant Engineer C. W. Sturtevant, as superintendent of dredges.

Testing new dredges.—During the past year four dredges, the *Gamma*, *Delta*, *Epsilon*, and *Zeta*, have been tested for efficiency and capacity, in accordance with the requirements of the contracts under which they were constructed. In all cases the dredges were given first an efficiency test, covering several weeks, and then tests with the measuring barge to determine their capacity.

The tests on the *Gamma* were commenced on June 16, at Arsenal Island, opposite St. Louis, Mo. The efficiency tests terminated on August 11, capacity tests on August 17, and deflection tests on August 19. During the efficiency tests 864¾ hours were spent in operating, 159 hours in repairs, 344¼ hours not operating. On June 19 the starboard crank-pin brasses became hot and gripped the crank pin so tightly that it was torn loose in the crank disk. The shaft with runner attached was removed for repairs, which were completed on June 25. The bearings, however, still continued to run hot when speeded above 100 revolutions; but finally, by careful scraping of the bearings and substituting babbitted crank-pin bearings, the revolutions were successfully increased to 150. The details of the capacity tests are shown in plate 21, attached.

The efficiency tests on the dredge *Delta* were begun on July 9 and continued until July 28. The capacity tests did not begin until July 29 and were completed on August 10. The time spent in efficiency tests was divided as follows:

	Hours.
Operating	453¼
Repairs	5 1/12
Not operating	66

The details of the capacity tests are given in plate 22 appended.

The dredges *Epsilon* and *Zeta* were delivered by the contractor at the same time and were tested together. The tests began early in January of the present year and due to the very unfavorable season, were frequently interrupted by high water and drift. Both dredges were throughout in the hands of crews selected by the engineer officer in charge, but an important difference of opinion arose between the engineer officer and the contractor as to the speed at which the engines should be operated. Apparently, by the terms of the specifications, it was originally contemplated that these engines should run from 200 to 225 revolutions per minute, and though some modification had taken place in their details during actual construction, I saw nothing involving a change in the speed requirements. Finally, by my orders, the engines on both dredges were speeded up to 200 revolutions per minute, though the contractor protested that 180 revolutions was the limit of safety, and that this speed was all that should be expected from the engines as modified. He also claimed that he was fully prepared to guarantee the capacity requirements at a lower speed. As a result of this high speed test, the starboard shaft on the dredge *Epsilon* cracked after running about five minutes, and the loosening of the fly-wheels on both dredges indicated that, with their present arrangements, at 200 revolutions the safety of the boats was likely to be endangered. Though the cards by this time had pretty well convinced me that 200 revolutions was not an economical working load for these engines, I still insisted that the contractor must provide lighter fly-wheels and properly secure them on to the shaft so that there would be absolutely no danger of their coming off, even when speeded to 200 revolutions, and that I could not consider them safe at 180 revolutions when showing such serious weakness at 200. In order to secure this change promptly from the contractor, I formally rejected the boats in accordance with the terms of the contract; but afterwards, by the permission of the Chief of Engineers, United States Army, this rejection was waived on account of the contractor having energetically gone ahead and substituted fly-wheels 19 inches less in diameter than those previously used. As a result of this, a five-hours' test at 200 revolutions on each dredge developed no evidence of any weakness, and all capacity and subsequent efficiency tests on both dredges were run at only 180 revolutions. The results of these capacity tests proved the truth of the contractor's claim that this speed was sufficient to fill the capacity requirements, and also that this speed is probably the highest that can be maintained economically. However, it is believed that a speed of 200 revolutions can be maintained for a considerable length of time without doing material injury to the engines and with a probable increase of capacity of 20 per cent.

During the tests of the U. S. dredge *Epsilon* the division of time was as follows:

	Hours.
Expended in placing plant	34¾
Dredging	456¾
Changing cuts	53¾
Repairs	46¼
Making up tow and towing	18
Capacity tests	110
Sundays, holidays, and authorized stoppages	118¼

The total duration of the efficiency tests was thirty-five days, and the percentage of lost time to available dredging time, considering only the first thirty days, was 10.32.

During the tests of the U. S. dredge *Zeta* the division of time was as follows:

	Hours.
Expended in placing plant	41½
Dredging	249¾
Changing cuts	16½
Repairs	37
Making up tow and towing	8½
Capacity tests	106¾
Sundays and holidays	260

The total duration of the efficiency tests was thirty days, and the percentage of lost time to available dredging time, 14.82.

The work of each day and the details of the capacity tests of the U. S. dredges *Epsilon* and *Zeta* are shown in plates 23 to 29 inclusive. Both dredges, at the final inspection after tests, were found in good condition, with the exception of some minor features, and were accepted; but the results of the tests showed so conclusively the superiority of the *Epsilon's* agitator to that of the *Zeta's* that it was finally decided that a jet agitator should be installed on the *Zeta* in addition to the present mechanical one. This will enable this dredge to make use of either or of both methods of agitating the sand, and in case of the injury of one agitator the other can be worked independently. The installation of this jet pump agitator on the *Zeta* is now in progress.

Dredging of low water channels during 1897.—The project under which last season's work was conducted contemplated the distribution of the four available dredges between Cairo, Ill., and Graves Bayou (250), each dredge being, so far as practicable, assigned to a particular section of the river. The original assignment was as follows: *Beta* from the mouth of the Ohio River to Phillips Landing, Mo. (81 R.); *Gamma* from 81 R. to Craigheads Point (170 R.); *Delta* from 170 R. to Graves Bayou (250 R.); *Alpha* from Graves Bayou southward. As expected, during subsequent operations it was sometimes found necessary to take dredges outside the limits of their districts.

Two survey parties, one on the steamer *Search* and the other on the *Vidalia*, divided the portion of the river from Cairo to Graves Bayou between them. Assistant Engineer C. W. Sturtevant was given the steamer *Minnetonka* as an inspection boat for the purpose of supervising all operations, and all locations of channels for improvement were approved by him before any dredging operations were begun. Each dredge was accompanied by a tender, pile sinker, and the necessary fuel and plunder barges. The *Beta*, being without any cabin, also required the services of a quarter boat and machine-shop boat. No tenders having yet been constructed for the dredges it was necessary to charter them. The tenders thus obtained were not entirely satisfactory, as comparatively few powerful low-water boats are in the market.

Before going into a detailed history of the field dredging operations of the past year and discussion of the results of this work, it is thought proper to describe the general principles which have governed the conduct of this important work.

It is generally admitted that all river-improvement works for the regulation of a nontidal stream, whether permanent or temporary, should be so arranged as to interfere with the course of nature as little as possible, and that every effort should be made to assist the working out of the natural plan and prevent the introduction of conflicting conditions which may impede its completion or disturb its future maintenance. In consequence, the end aimed at in a complete system of permanent improvements is, first, to establish and maintain a natural high-water bed; and, second, to provide within the limits of this bed a suitable low-water bed into which the river will naturally contract each year.

Where the high-water channel has not been permanently fixed it is useless to construct expensive low-water works, which may soon become obsolete and even dangerous obstructions. Our only recourse in such case is by means of dredging, or other temporary works of cheap construction, to open a suitable low-water season at as early a period in each year as practicable. If this is successful, navigation for the low-water season immediately following will be no more impeded than if a complete permanent system of improvement has been completed.

If, now, we assume the existing bank lines when the falling stage begins, as permanent for a single season, the construction of the proper temporary low-water channel for that season should be governed by essentially the same principles as applied to the establishment of a suitable low-water bed for a river whose high-water bed has been permanently fixed. Therefore, the principles taught by experience with permanent works can, within certain limits, be made applicable to those of a temporary nature. Those which seem to be most applicable to our temporary works as well as to permanent low-water improvements, are well stated by M. Girardin, Ingenieur en Chef, des Ponts et Chaussees, in a paper on "Regulation of rivers at low water," read before the Sixth Inland Navigation Congress at The Hague, in 1894. He groups all crossings in a river with a movable bed under two heads: First, where the upper and lower pools point toward one another, and the thalwegs immediately above and below the bar separating these pools are coincident; second, where the upper and lower pools overlap one another, the thalwegs above and below the intervening crossing being approximately parallel but not at all coincident. The permanent low-water improvement of the Rhone is being conducted by this engineer on the plan of converting all overlapping pools of the second class into pools pointing toward one another of the first. That the first type of crossing would be the one most easily navigated is almost self-evident, and M. Girardin presents strong facts to prove that the depth on the bars obtained by this plan of improvement is the greatest that can be obtained by mere regulation works.

The applicability of the above to our temporary improvements is made more evident by considering the cycle of changes through which a river channel passes during the falling stage. At the beginning the future low-water pools are considerably separated on account of the great deposit at the lower end of the upper pool during the previous high water. The main channel across the bar at this time will be comparatively straight and in good alignment with the thalwegs above and below—first, because the upper and lower pools are farther apart and the change from one to the other is distributed over a longer distance; and, second, because the slope of the river is more uniform and irregularities of the river bed are too deeply submerged to exert a material influence.

But, as the fall progresses, the lower end of the upper pool rapidly cuts out, and as the deposit in the lower pool forms much more slowly than this cutting-out process above, the upper pool seems to travel downstream; the irregularities of the river bed also begin to exert an important influence, especially on the direction of the main channel across the intervening bar.

If, as the river falls, the shape of its bed is such that the water at the foot of the upper pool is funneled toward the head of the lower pool, both high and low water channels will remain approximately coincident throughout, and we have a perfectly natural improvement.

But if the funneled water above is not pointed toward the head of the upper pool, but toward some other point considerably lower down, the river must tend to cut out a new low-water channel entirely outside of the former high-water crossing, and continued difficulty must be experienced by navigation interests during the changing period. This is illustrated roughly in fig. 1 below. The high-water pools A B C and E D F are connected by a direct crossing B D when the falling stage begins. The limits of these high-water pools and the high-water crossing are marked by a full line. As the river falls cutting out begins along the side A B, due to the irregularities of the bed, and we have the upper pool in the position A′ B′ C′ connected to the lower pool E′ D′ F′ by the crooked channel B′ D′. The limits of the upper and lower pools at low water and the connected low-water channels are marked by broken lines in the figure. The upper pool is now directed on a point, E′, below the head of the lower pool, and we have the case of the overlapping pools. In time a cut-off from B′ to E′ will be made, which may become the permanent low-water channel if not too direct; otherwise caving and deposit will continue, resulting possibly in another cut-off still farther down. If this appears impossible on account of the character of the bed, the line B′ E′ would undoubtedly be the route to open as early as practicable by dredging, and thus simply hasten and assist the natural movement.

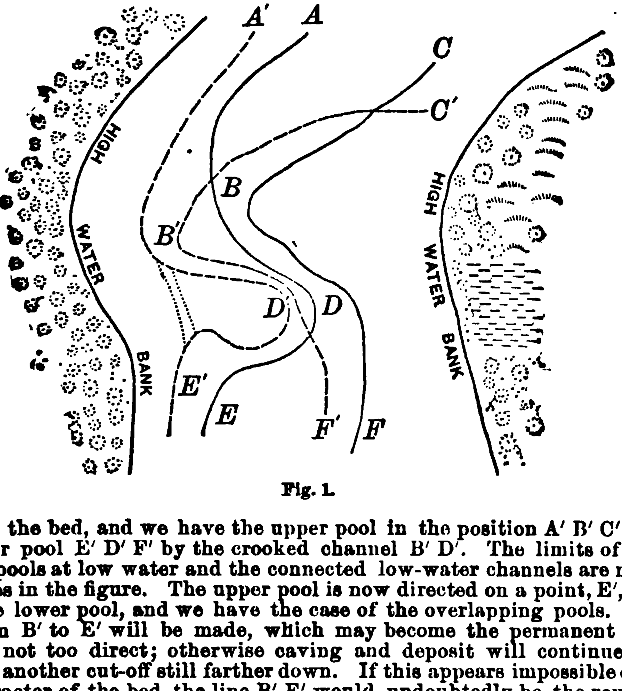

Fig. 1.

In the above example the simple case of one set of inlets and outlets has been considered, but in the lower Mississippi the situation is always more complicated. Nevertheless, whenever the main pools, even approximately, point toward one another when first examined the subsequent change in location of the main low-water channel is never sufficient to cause material difficulty in navigation. A typical case is not available for illustration, because such crossings, being always found in good condition, do not require an examination or survey. Something resembling, however, these ideal conditions is shown on plate 54, in the vicinity of Cherokee Crossing, surveyed September 9–11, 1897. The pools do not point exactly toward one another, but the future permanent low-water crossing B C is already so far advanced as to indicate its early completion, and the high bars out of water below show clearly the impossibility of its future deterioration. At the time of this survey the actual crossing used by vessels was the very crooked one from B to A, but on his first examination, immediately prior to this survey, the superintendent of dredging selected the route from B to C and found already available more water through this channel than through the upper one. It continued to improve and remained practically permanent with 9 feet or over throughout the season.

Another noticeable feature of the Mississippi is the frequent existence of dead pools or dead ends of existing pools. These are similar in character to the pieces of old river cut off from the main river bed at high water; they are the main pools of a previous season. The main low-water channel of a subsequent season can not, however, be made to return to these old pools, as the curvature would be unsuited to the conditions since established. The water, therefore, in these old pools has comparatively little current, and is known in pilots' language as "duck water." Pilots never attempt to follow these dead pools, as they know they will be found obstructed at one end or the other. Wherever they are contiguous to the main pools, however, they are liable to seriously impair the main low-water crossing by drawing off the water through side routes, thus interfering with the progress of the upper pool downstream toward its natural outlet. In the plate just referred to, of Cherokee Bar, the end of the lower pool above the point C is a dead arm of this character; its upper end, however, is entirely closed by a large sand bar, which prevents its forming any outlet for the pool above. The main channel in 1896 was right through this sand bar into the present dead arm of the lower pool. In another case, hereafter discussed (Sam Phillips Crossing), the numerous overlapping dead pools continued throughout the season to seriously impair the main channel without materially improving any of the branch ones.

The question of the proper location of the probable future low-water channel is, therefore, as important for a temporary improvement as for a permanent one and calls for the exercise of careful study and good judgment. To assist in the determination advantage must be taken of all information bearing on the matter at our command. A decision ought not to be made from the study of mere surface indications, but only after giving careful consideration to the bed indications entirely out of sight. There is no way by which these latter indications can be determined and studied except by a map. The surface indications should be obtained by a careful examination of the ground from the point of view of the pilot.

To show the bed indications the map must be constructed from a hydrographical survey, with the limits of those pools which have more than the required depth carefully contoured; other contours of less depth should also be drawn in, as it is impossible to tell in advance which one will be the "controlling contour," which should decide. This controlling contour will always be the one that shows the most pronounced indications, provided the others do not show conflicting indications. All dry bars, low-water caving, Government lights, existing direction of currents, and present steamboat channels should be shown on the map. With a bad crossing there will usually be found two main pools with their shallower contours considerably overlapping. These shallower contours will be found crossing, or nearly crossing, the bar at one or more points, and those contours with the greatest depth running across the bar will ordinarily define the existing steamboat channel; the others indicate either incipient or abandoned channels. As the upper pool travels downstream all the time, the abandoned channels will always be the upper crossings and the incipient channels the lower ones. Furthermore, the future main low-water channel should be the lowest of any which have any chance of being opened during a single low-water season.

At all well-advanced incipient channels where the contours above and below do not join they will approach one another by a branch reaching out from the upper pool, with a corresponding loop or "tit," as it is commonly called, pointing toward it from below. This tit is formed by the cutting out of the sand from the bar above and its deposition in the pool immediately below, or, in pilots' language, by the "tailing down" of the bar above. The sand in this process travels over the bottom in a succession of waves, just as can be seen on a small scale in any rivulet with a movable bed.

The surface indications are more difficult to explain, though they constitute the entire stock in trade of the experienced pilot. The main reef lines are well defined by the rough water below at low water, but the continuous smooth water above prevents any exact knowledge of the limits of the upper pool or of the direction in which it is tending as a whole. Where good channels are actually in existence they will be indicated by streaks of smooth water piercing the reef lines. At various points below such channels whirlpools or scouring boils of considerable size will be noticed. They cover usually a triangular area with the base just below the reef line and the apex some distance above. The boils diminish in size and finally disappear in passing from the base to the apex of a triangular area.

These scouring boils cover the tits in the lower pool already referred to, and indicate the outlets of incipient channels well advanced in formation. They are often called by pilots "soft places," and it is a common practice with them when in doubt to "butt" the reef from below at these places, aiming to mount the reef at the apex of the triangular area.

These boils are of particular importance if there is a caving sand bar in sight just below, as it shows a strong draft of water through the new channel. For the same reason a floating log (sometimes called "a good pilot") is carefully watched, as, if it turns into the new channel it is an indication that the abandonment of the old has already begun. In fact, it is a common practice of pilots going downstream, when lost, as at night, to simply stop their boats and float. If not far out of their course when beginning this maneuver the chances of successfully dropping through the best channel are regarded as good.

All of these surface signs are best seen on a calm, clear morning, with the sun at the back and not far above the horizon. Frequently the reef line can be shown up by "breaking it up," which consists in running a steamboat below in the vicinity and with her wheel producing breakers on the crest of the bar.

Our experience indicates that a mistake is practically never made in putting the outlet of a channel selected too low down. On the other hand, the nearer the upper end comes to the foot of the upper pool the better. In many cases, however, the length of the cut to be dredged prevents extending it as far downstream as might be desirable. However, if any mistake in this particular is made before low water is reached it can not be considered entirely as lost ground, as the effect, at any rate, has been to draw the pools closer together and make the formation of a new channel still lower down a matter of much less time.

There are other important reasons, however, why the work should be done as early during the falling stage as possible. At the higher stages there will usually be more than one route available for existing navigation, but at the lowest stage a large part of the channel needing improvement will be the only one having any considerable depth, and the dredges must be constantly interfered with by passing boats, thus entailing extra expense and great loss of time. The difficulties of selection are of course greatly increased at the higher stages, but it is well worth while to run the risk of making mistakes in order to have the low-water channels ready for the river when they are needed, and thus cause the least possible delay to existing navigation. With dredges, of course, the time at which work on a bar can begin depends upon the depth to which they can work to advantage.

HISTORY OF PAST SEASON'S WORK.

Dredge Alpha.—This dredge did not get into the field until the 12th of October on account of the breaking out of yellow fever aboard while lying at East Cairo, Ky., and the quarantining of the same by the United States Marine Hospital Service. From that time to the close of the season the dredge was worked at four different bars: Medleys (30), Sam Phillips (81), Gold Dust (158), and Fleeces (243). On November 28 the boat was moved to winter quarters. The conditions of the work, division of time by hours, and the amount of expenditures at each bar are given on plates 89 and 90.

Dredge Beta.—This dredge was moved into the field on the 1st of September and its operations were confined entirely to the vicinity of Point Pleasant, Mo., on two bars, known as Upper Point Pleasant (79) and Sam Phillips (81). This section of the river proved the worst between Cairo and Memphis and, on account of the excessive draft of the *Beta*, our success was not what should have been expected. At Upper Point Pleasant she failed to get below the bar, so as to begin work upstream, until a channel had been cut through by the *Gamma;* and at Sam Phillips (81) the same difficulty was met with, which, on account of a breakdown of the *Gamma* at the same time, involved the loss of three weeks' time. The *Beta* was finally pulled down through this bar headon. This operation took several days, with the boat aground on one side in 4 feet of water most of the time; and when the lower pool was finally reached all of the joints of the suction pipes had been so loosened up that some two days more were required to tighten them up ready for work. This boat, also, while at work at dead low water, formed so great an obstruction in the channel as to really, at times, improve side channels by obstructing the flow of the water through the main channel. Toward the close of the season considerable work was done in stopping the side channels, which proved very beneficial to the maintenance of the depth in the main channel. Plates 89 and 90 give the division of time and the expenditures at each bar for the dredge *Beta.*

Dredge Gamma.—This dredge was in the field throughout the entire season and, with the exception of one breakdown, due to the breaking of the cast-iron flanges connecting the suction pipes to the bulkhead, worked almost continuously. At various times the following bars were worked on by the *Gamma:* Lazelles (82.5), Sam Phillips (81), Upper Point Pleasant (79), Hathaways (104.2), Rocky Point (160), Batsells (91). On plates 89 and 90 will be found the division of time by hours at the various bars, and the expenditures at each bar.

Dredge Delta.—This dredge worked in the field from the 1st of September until the close of the season. Channels were dredged at Island 34, upper and lower reef

(179); Island 40 (211), Presidents Island (235), Osceola Bar (164), Graves Bayou (250). No breakdowns of any great length occurred during the season, but hardly a day passed without a stoppage being caused by the cutter machinery; several collisions also occurred with passing boats. The number of hours spent in actual dredging was less by considerable than that spent in repairing. On plates 89 and 90 will be found the division of time by hours and the cost of the work at each bar. Our experience with this boat indicates very clearly that before another season the cutter machinery should be removed and a jet agitator substituted. The cutter machinery consists of a series of arms like a cultivator's, which revolve about a horizontal axis. The consequence is that anything in the shape of drift or snags which are buried in the sand is bound to be picked up and will soon catch and jam the agitators. If a mechanical agitator is to be used it is probable that a form revolving about a vertical shaft—of the Bates' pattern—is preferable.

On plates 89 and 90 will be found a table showing the condition of the work as performed by the four dredges and a combined table showing the division of time by hours.

Considering horsepower and capacity, the *Gamma* has proved, so far, ahead of any of the rest for field use, principally on account of her light draft and jet agitator.

DISCUSSION OF RESULTS.

Careful surveys were made of the bars under improvement before and at various times after dredging, the results of which are illustrated on plates 31 to 88. The project provides for a depth of 9 feet at lowest water, and all depths greater than this are shown on these maps with parallel ruling. In determining what should be considered low water in advance it was decided to use a mean of the lowest waters recorded on the permanent gauges of the Mississippi River Commission from their establishment in 1871 up to 1896. The low-water gauges at the bar were set as nearly as practicable to read the same as the nearest main gauge. The following low-water datums were adopted: Cairo, 4.01 feet; Belmont, 3.59 feet; New Madrid, 2.19 feet; Cottonwood Point, 0.4 foot; Fulton, 3.88 feet; Memphis, 1.85 feet. On account of the smaller rate of fall on the shoals than in the pools these low-water datums were generally found sufficiently low, though there were some cases where this is not true, as indicated on the maps. The fluctuations in the main gauges during the season are shown on plate 30.

Medleys Crossing (*30 R.*).—Before dredging and one day after dredging is shown on plates 31 and 32. The only object of dredging was to widen and straighten the channel by cutting off a projecting point. This was effectively accomplished, and the channel continued to improve throughout the rest of the season.

Vicinity of Point Pleasant.—The general condition of affairs at the opening of the season is illustrated on plate 33. It was recognized that this stretch of the river was likely to have the shoalest crossings of any part between Cairo and Memphis; the shoal crossings also being so close together it was necessary to take into consideration the effect of the opening of one upon any of the others below. Numerous side channels leading into dead pools are indicated on the map. The main channels are Upper Point Pleasant Crossing, Lower Point Pleasant Crossing, Sam Phillips Crossing, Darnells Crossing, between D and M on the map, and Lazelles Crossing. Starting from the upper pool A B it is possible to follow down the right bank throughout to the lower end. A large portion of the deep water along this route, however, is absolutely without current, and was rapidly silting up at its upper end. Considering the usual curvature followed by low-water channels on the Mississippi River, it was thought that the crossing at Upper Point Pleasant, Sam Phillips, and Lazelles held out the most promising indications of permanence. Sam Phillips Crossing was an entirely new cut made through a dry bar by the river after the last flood and, at the time of the first inspection, was rapidly improving. Subsequent experience only confirmed this selection, and proved at the same time that the only practicable method of permanently maintaining this route was to close Lower Point Pleasant Crossing on the one side and Darnells Crossing, between D and M, on the other. Unfortunately, this last was not accomplished until the latter end of the season.

Plates 34 to 36 show the conditions and results at Upper Point Pleasant. At the time of the first examination the route from B to C (plate 34) was the steamboat channel. It will be noted that the route selected enters the lower pool much farther down and passes over a projecting tit from the lower pool. The results one day after dredging are shown on plate 35. The dredging of this bar was hardly extended far enough upstream, though it is generally expected that the dredged channels will improve themselves at the upper end without entirely cutting through the bar. However, even twenty-three days after dredging, a good channel was found with an actual depth at the time of the survey of over 8 feet. This channel was then straightened by the *Gamma* and its depth increased to over 9 feet by a few days' dredging. At this crossing a depth of 8 feet was maintained practically throughout the season.

Plates 38 and 39 illustrate the filling in Lower Point Pleasant. The effect of this filling on the channel at Sam Phillips, immediately below, was very beneficial.

Plates 40 to 49 illustrate the condition at Sam Phillips Bar at various stages of the work. On plate 40 the proposed filling of Darnells Crossing was, as before stated, not completed until later in the season.

The survey of September 13 indicates a crooked channel with less than 6 feet reduced depth. This condition of affairs, as before stated, prevented the *Beta* from getting over, and work was begun by the *Gamma*, the effect of which is shown on plate 41. The depth was increased to 7 feet or more up to the point E, when a breakdown occurred, and for a time neither dredge could be utilized, the *Beta* being still above the bar. The effect after the *Beta* had been pulled down over the bar and had been up this channel is shown on plate 42. The conditions at this time were very favorable, the reduced depth being 7 feet and the actual depth being over 8 feet. The channel, however, somewhat deteriorated at the upper end, due to the drawing off of the water at Darnells Point, as illustrated in the next plate, survey of October 24-25. At this time a shoal had developed which had less than 6¼ feet actual depth. The filling was then begun by the *Beta* in Darnells Channel and the lumps at the upper end were removed by the *Alpha*. The conditions are then shown on plate 44. From this it appears at this time a channel of over 8 feet existed throughout, except at the lower end of the bar, where the reduced depth was 5.8 feet, or about 6¼ feet actual depth. This shoal, however, only lasted for a day or two, being evidently due to the cutting out of the material above. It was improved, however, by the *Gamma*, as shown by the next plate, taken some two weeks later.

Plate 46, survey of November 14, shows the condition at the upper end, being nearly 9 feet through this channel, which is rapidly improving on account of the filling of Darnells Channel. From this time on not less than a 9-foot actual channel was maintained.

Considering everything, great success can not be claimed for the operations at Sam Phillips. The depth undoubtedly several times fell down to very little over 6 feet. These periods, however, were short, and most of the trouble with steamboats was due to the frequent changes in the channel with which pilots were unable to keep themselves posted. Furthermore, the strong current through some of the side channels prevented close steering with tows.

Plates 50 to 52 show Lazelles Bar before dredging, one day after dredging, and thirty-one days after dredging. This channel is well located along the axis of the upper pool and, after opening a depth of nearly 8 feet, was maintained throughout the season. No difficulty was experienced with boats at this point.

Plates 55 to 57 show Batsells Bar (91) before and after dredging. This shoal developed very quickly and was removed in a very few days. Practically, after dredging, nothing less than 9 feet was found during the season.

Hathaways Upper Crossing (*102*) *and Lower Crossing* (*104*).—The location of these two crossings is indicated on plate 58. It will be noticed that a boat following one route does not have to make the other crossing. Hathaways Upper Crossing, however, though existing every year, is never found the main channel at dead low water. The examination, near the end of September, of this shoal indicated very clearly that nearly all of the water in the river was going the lower way, though a narrower and deeper channel could be found above. Plates 59 to 61 show clearly the effect of the dredging. This lower crossing was not at any time as serious an obstruction as some others, but the beneficial effect of dredging is very apparent.

Gold Dust Crossing (*158*).—This is shown before and after dredging on plates 62 to 64, the effect being to at once obtain a 10 or 11 foot channel.

Rocky Point (*160*).—This was a very close place along the right bank, and which was materially obstructed by a projecting bar on the left, as shown on plate 65. There was another wider channel, which time did not permit the examination of, on the other side of the river, but it is a great advantage to steamboat interests to have the channel close to the bank, if possible, as they can follow it so much better. It was, therefore, decided to simply improve this channel by cutting off a projecting bar, and the effect of this removal is shown on the next plate. The necessary depth was attained and maintained without difficulty.

Plates 68 to 70 show the effect of dredging at Osceola Bar, a channel of the required depth being opened and maintained very successfully.

Plate 71 illustrates the general conditions in the vicinity of Island 34. There are two crossings which were worked on at different times, one known as the upper and the other as the lower, as indicated on the plate. On plates 72 to 74 are shown the conditions before and after dredging at the upper crossing. The dredging consisted merely in the widening of an existing channel. The results at the lower crossing are illustrated in plates 75 to 77, and here, I think, the success of the dredging is more pronounced than at any other locality. The river tended to improve on the lower side of the dredging, as would be expected, and where at the time of the first survey only about 6¼ feet of steamboat water was available not less than 8 or 9 feet was maintained after dredging, throughout the season.

Plate 78 illustrates the chute of Island No. 40, which was one of the most serious problems of the season. The wreck of the *City of Hickman* is shown near the center of the map. This boat was sunk in 1896 and drifted down into the center of the chute, forming two bad channels on its upper and lower side. It was hardly to be expected that with this wreck in the way an entirely satisfactory improvement of the channel could be hoped for. The probable cause of the shoal itself was the existence of the wreck. Considering everything, however, it was deemed best to attempt the improvement of the channel on the upper side of the wreck, which would be an advantage to downstream navigation—always the most difficult to handle. The results of the dredging as shown by the next plate are very favorable. Plate 80, fifty-three days after dredging, indicates, however, that a channel was broken through on the lower side as well as the upper.

Plate 81 shows the conditions at Presidents Island before dredging on October 4–8. There was really at this time important work needed above Memphis, but immediate relief at this bar was so pressing that I directed the *Delta* to proceed below Memphis and make an opening as rapidly as possible without waiting to carefully investigate the question of proper location. This first survey shows nothing of the state of affairs on the island side of the river, and it is probable that at this very time the upper pool had extended a considerable distance down toward the bottom of the map. The channel selected, however, was the one followed by the light-draft boats, its depth being only about 6 feet. On the next plate the dredged channel is clearly shown, though somewhat narrow, but it will be noticed that the upper pool on the opposite side of the river extends well downstream. Plate 84 shows not only the dredged channel, but also that the pool on the opposite side of the river has broken through and the depth in this new channel is about the same as in the dredged channel. It is probable that at this point the other channel should have been the one selected for improvement, and that a mistake was made in the original examination in not covering a sufficient amount of territory with the survey. The omission in this particular was due to the great pressure of work and the small plant available.

Plates 85 and 86 show the condition of Fleeces Crossing before and after dredging. This was not a serious obstruction; the effect of the dredging, however, was to straighten the channel and thereby benefit navigation.

Graves Bayou, as usual, was one of the worst shoals in the Mississippi River. Unfortunately, no dredge was available for work at this locality until comparatively late in the season. The conditions when first examined were about as shown on plate 87. An upper channel between 7 and 8 feet (a rather crooked one) was in existence. However, boats would generally run over lumps of not over 6 feet in making the crossing. The lower one, as shown by the map, is apparently the proper one for dredging. Plate 88 shows the results of the dredging.

These plates show, I think, very clearly the beneficial effects of last season's work. They also, however, show the necessity of a sufficient plant to produce these effects in a very short time. The results were all that I had expected, except at Point Pleasant, and there our nonsuccess was due not so much to the conditions as to the great draft of the dredge *Beta* which prevented her getting over the bars for work. This will be removed for next season, and we may hope for quite a different record.

Besides the surveys frequent inspections were made with the steamer *Minnetonka*, and a depth of more than 7 feet was found at all times from Cairo to Memphis throughout the low-water season, except from September 20 to November 10, when only 6 feet and 6½ feet existed at Sam Phillips, about one-half of this time the depth being 6½ feet. On November 12–14, at about the lowest stage of the season, Maj. Thomas H. Handbury and Henry Flad, members of the committee on dredges, made a trip from Cairo to Graves Bayou on the steamer *Minnetonka*, and found 8 feet in the channel.

Additional details are given in the appended reports of Asst. Engineer C. W. Sturtevant, whose services as superintendent of dredging during the past season have proved extremely valuable. (Appendixes 1 E and 1 F.)

COMMERCIAL STATISTICS.

Commercial statistics pertaining to the Lower Mississippi River can only be obtained by employing special agents for their collection. The past year the commerce was seriously interfered with by yellow fever, which resulted in the quarantining of all through traffic. The Valley Line tows were also impeded by the shoal water at Sam Phillips, but it is believed that their delays would not have been one-half so long as actually occurred if there had been no difficulty in securing crews for operating in the yellow-fever districts. The traffic of the winter season, however, has been very large, especially in the grain-shipping trade.

The following papers accompany this report:

Money statement.

Abstracts of all proposals, in the order of date of opening bids.

List of contracts in force, with names of contractors, dates of approval, dates of beginning work, and dates of expiration.

Statement of charts issued and sold.

List of civilian engineers.

Approximate value of plant.

Appendix 1 A, laws affecting the Mississippi River Commission, July 1, 1897, to June 30, 1898, inclusive.

Appendix 1 B, specifications for alterations to the hydraulic dredge *Beta*, and for the construction of 4 pile sinkers, 3 small tenders, and 5 large tenders.

Appendix 1 C, report of Asst. Engineer J. A. Ockerson on office work, surveys, and collection of physical data.

Appendix 1 D, report of Asst. Engineer Thomas Middleton on construction, alteration, and repairs to plant.

Appendix 1 E, report of Asst. Engineer C. W. Sturtevant on care and repair of plant in the field, testing of new plant, and dredging operations on the Lower Mississippi River, between Cairo, Ill., and the Head of the Passes, Louisiana.

Appendix 1 F, report of Asst. Engineer C. W. Sturtevant on tests of U. S. dredge *Alpha*.

Respectfully submitted.

H. E. WATERMAN,
Captain, Corps of Engineers,
Secretary Mississippi River Commission.

Brig. Gen. G. L. GILLESPIE,
Colonel, Corps of Engineers, U. S. A.,
President Mississippi River Commission, New York, N. Y.

Money statement.

July 1, 1897, balance unexpended		[*] $436,186.40
Amount allotted from appropriation by act of June 4, 1897	$869,010.00	
Amount allotted from appropriation by act of July 19, 1897	([†])	
Amount transferred from allotment for "Dredges and dredging," Fourth district	9,457.82	
Amounts received from refundments of overpayments	.44	
		878,468.26
		1,314,654.66
June 30, 1898, amount expended during fiscal year	593,959.96	
Amount transferred to allotment for "Ashbrook Neck," Third district	8,944.44	
Amount transferred to allotment for "Dredges and dredging," Fourth district	10,000.00	
		612,904.40
July 1, 1898, balance unexpended		701,750.26
July 1, 1898, outstanding liabilities	180,453.74	
July 1, 1898, amount covered by uncompleted contracts	334,296.52	
		514,750.26
July 1, 1898, balance available		187,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1900		858,400.00

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[*] The balance, $459,596.40, shown in Annual Report for 1897 erroneously included an allotment of $23,410, which is omitted herefrom.

[†] This amount, $254,000, having been authorized by act of June 3, 1896, to be contracted for, was taken up in money statement with Annual Report for 1897, and is included in the amount of balance unexpended, July 1, 1897.

Abstract of proposals for the construction of one pile sinker, received in response to advertisement dated June 21, 1897, and opened by Capt. H. E. Waterman, Corps of Engineers, July 7, 1897.

No.	Name and address of bidder.	With wooden hull and leaders.	Steel-framed hull and wooden leaders.	Steel hull and wooden deck and leaders.	Extra for metallic leaders.
1	The Cincinnati Marine Railway Co., Cincinnati, Ohio	$1,465	$2,780	$3,675	$85

Bid for pile sinker with wooden hull and leaders at $1,465 accepted.

Abstract of proposals for making alterations to hull of U. S. dredge Beta, received in response to advertisement dated January 28, 1898, and opened by Capt. H. E. Waterman, Corps of Engineers, February 12, 1898.

No.	Name of bidder, and of parties to whom circulars were addressed.	Price for job complete.	Remarks.
1	Iowa Iron Works, Limited, Dubuque, Iowa	$26,900	Accepted.
2	John O'Brien Boiler Works Co., St. Louis, Mo	64,000	
	The Springfield Boiler and Manufacturing Co., Springfield, Ill		No bid.
	American Steel Barge Co., West Superior, Wis		Do.
	Cleveland Ship Building Co., Cleveland, Ohio		Do.
	Craig Ship Building Co., Toledo, Ohio		Do.
	Globe Iron Works, Cleveland, Ohio		Do.
	Chicago Ship Building Co., Chicago, Ill		Do.
	F. W. Wheeler & Co., West Bay City, Mich		Do.
	Bell's Steam Engine Works, Buffalo, N. Y		Do.
	Riter & Conley, Pittsburg, Pa		Do.
	James Rees & Sons Co., Pittsburg, Pa		Do.
	Ed. J. Howard, Jeffersonville, Ind		Do.
	Missouri Valley Bridge and Iron Works, Leavenworth, Kans		Do.
	Fulton Iron Works, St. Louis, Mo		Do.
	John Rohan & Sons Boiler Works Co., St. Louis, Mo		Do.

Abstract of proposals for furnishing coal, received in response to advertisement dated February 14, 1898, and opened by Capt. H. E. Waterman, Corps of Engineers, March 16, 1898.

[Lot 1: 160,000 bushels coal in 15 new barges, delivered at New Madrid, Mo.]

No.	Bidder.	Price of barge, each.	Price of coal per bushel.	Total cost.
1	Frederick Hartweg, Cincinnati, Ohio:		*Cents.*	
	Catsburgh mine	$1,050	5.9	$25,190
	Elizabeth mine	1,050	5.9	25,190
2	Samuel S. Brown, Pittsburg, Pa., Brown's Youghiogheny, Nos. 1 and 2 mines	1,050	7.5	27,750
3	C. Jutte & Co., Pittsburg, Pa., Apollo mine	1,250	5.5	27,550

[Lot 2: 190,000 bushels coal in contractor's barges, delivered at New Madrid, Mo.]

1	Frederick Hartweg, Cincinnati, Ohio:		
	Catsburgh mine	6.9	$13,110
	Elizabeth mine	6.9	13,110
	Coalburgh, Cedar Grove, Chesapeake, Edgewater, Splint, or Monarch mines	6.9	13,110
2	Samuel S. Brown, Pittsburg, Pa., Brown's Youghiogheny, Nos. 1 and 2 mines	7.75	14,725
4	S. F. Dana, Cincinnati, Ohio, Campbells Creek or Black Diamond mines, including second-hand barges containing the coal	7.25	13,775

[Lot 3: 350,000 bushels coal in contractor's barges, delivered between Cairo, Ill., and Helena, Ark., as needed.]

1	Frederick Hartweg, Cincinnati, Ohio:		
	Catsburgh or Elizabeth mines	[a] 10.4	$36,400
	Coalburgh, Cedar Grove, Chesapeake, Edgewater, Splint, or Monarch mines	10.4	36,400
2	Samuel S. Brown, Pittsburg, Pa., Monongahela, Old Eagle, and Black Diamond mines	10.5	36,750

[a] Accepted.

Abstract of proposals for furnishing duplex pumps, received in response to advertisement dated February 24, 1898, and opened by Capt. H. E. Waterman, Corps of Engineers, March 26, 1898.

No.	Name and address of bidder.	Description of pump.								Price for 2 pumps.
		Type of pump.*	Diameter of cylinder.				Stroke.	Steam used per H. P. per hour.	Weight.	
			H. P.	I. P.	L. P.	Water.				
			In.	*In.*	*In.*	*In.*	*In.*	*Lbs.*	*Lbs.*	
1	L. M. Rumsey Manufacturing Co., St. Louis, Mo. (Blake or Knowles pump)	C.	10	......	20	16	15	28½	34,000	$4,444
		C.	10	......	20	16	18		37,000	4,672
		T.	8	14	24	16	15		47,200	*a* 5,468
2	Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio	C.	9½	......	18	15	18	28	53,300	3,600
		T.	7½	13	24	15	18		69,300	5,200
3	Deane Steam Pump Co., Holyoke, Mass *b*	S.	14	......	......	16	18	......	54,000	*b* 3,990
		C.	9	......	16	16	18	......	60,000	4,490
4	The Jno. H. McGowan Co., Cincinnati, Ohio	C.	10½	......	18½	17	18	......	43,000	4,500
5	M. T. Davidson, Brooklyn, N. Y	C.	14	......	26	16	18	......	....	7,200
6	Stillwell-Bierce & Smith-Vaile Co., Dayton, Ohio *c*	C.	8	......	12	16	15	......	30,000	2,780
7	The Manhattan Supply Co., New York, N. Y. (Worthington pump)	C.	10	......	17	16	15	26½	50,000	4,609
		T.	8	12	20	15	15		60,000	7,540
8	Henry R. Worthington, Brooklyn, N. Y	C.	10	......	17	16	15	26½	50,000	4,619
		T.	8	12	20	15	15		60,000	7,550
9	Thompson C. Gill & Co., Philadelphia, Pa. (Worthington pump)	C.	10	......	17	16	15	26½	50,000	4,920
		T.	8	12	20	15	15		60,000	7,720

* S. = single; C. = compound; T. = triple expansion.

a Accepted for 2 Blake triple-expansion duplex pumps at $2,734 each.
b Contrary to specifications.
c Engine too small.

Abstract of proposals for furnishing boilers, received in response to advertisement dated March 17, 1898, and opened by Capt. H. E. Waterman, Corps of Engineers, April 2, 1898.

No.	Name and address of bidder.	Price of boilers complete.
1	John O'Brien Boiler Works Co., St. Louis, Mo	*a* $2,740
2	John Rohan & Son Boiler Works Co., St. Louis, Mo	2,785
3	Jos. F. Wangler Boiler and Sheet Iron Works Co., St. Louis, Mo	3,714

a Accepted.

Abstract of proposals for furnishing three small steam tenders, received in response to advertisement dated March 14, 1898, and opened by Capt. H. E. Waterman, Corps of Engineers, April 14, 1898.

No.	Name and address of bidder.	For 1 tender.	For 2 tenders, each.	For 3 tenders, each.
1	M. A. Sweeney Co., Jeffersonville, Ind	$7,949	$7,849	*a* $7,749.00
2	Ed. J. Howard, Jeffersonville, Ind	8,455	8,455	8,455.00
3	Iowa Iron Works, Limited, Dubuque, Iowa	8,950	8,725	8,650.00
4	The Cincinnati Marine Railway Co., Cincinnati, Ohio	9,047	9,000	8,966.67
5	The Springfield Boiler and Manufacturing Co., Springfield, Ill	12,000	11,750	11,500.00
6	Shook-Anderson Manufacturing Co., Pittsburg, Pa	13,622	13,300	12,998.35
7	Craig Ship Building Co., Toledo, Ohio	14,000	13,500	12,450.00

a Accepted for 3 tenders.

Abstract of proposals for furnishing four pile sinkers, received in response to advertisement dated March 14, 1898, and opened by Capt. H. E. Waterman, Corps of Engineers, April 14, 1898.

No.	Name and address of bidder.	Price.
1	The Cincinnati Marine Railway Co., Cincinnati, Ohio..........	[a]$1,684
2	Iowa Iron Works, Limited, Dubuque, Iowa..........	1,795
3	Ed. J. Howard, Jeffersonville, Ind..........	2,100

[a] Accepted.

Abstract of proposals for furnishing five large steam tenders, received in response to advertisement dated April 27, 1898, and opened by Capt. H. E. Waterman, Corps of Engineers, May 27, 1898.

No.	Name and address of bidder.	One tender (No. 1, 2, 3, or 4).		Two tenders (No. 1, 2, 3, or 4).		Three tenders (No. 1, 2, 3, or 4).	
		Price.	Time for completion.	Price, each.	Time for completion.	Price, each.	Time for completion.
			Months.		*Months.*		*Months.*
1	Iowa Iron Works, Limited, Dubuque, Iowa..........	$45,990	10	$45,740	10	$45,490.00	10
2	Craig Ship Building Co., Toledo, Ohio..........	49,975	6	49,586	1-6 1-7	49,250.00	1-6 2-7
3	The Springfield Boiler and Manufacturing Co., Springfield, Ill....	57,867 57,367 58,017	9	56,839 56,375 57,417	10	56,496.33⅓ 56,084.33⅓ 57,217.00	11
4	Ed. J. Howard, Jeffersonville, Ind..........	....	....	51,320	10 and 12	....	....
5	Edward Flad, St. Louis, Mo..........	67,542	7	63,773	9	63,574.00	10
6	Marietta Boiler Works, Marietta Ohio..........	....	....	61,434	6 and 9	....	....
7	The Cincinnati Marine Railway Co., Cincinnati, Ohio..........	65,464	8	65,464	10	....	....
8	Shook-Anderson Manufacturing Co., Pittsburg, Pa..........	68,250	10	67,450	11	....	....
9	Riter-Conley Co., Pittsburg, Pa....	73,900	9	73,900	10	73,900.00	11

No.	Name and address of bidder.	Four tenders (No. 1, 2, 3, and 4).		One tender (No. 5).		Two tenders (No. 5 and one of Nos. 1, 2, 3, and 4).	
		Price, each.	Time for completion.	Price.	Time for completion.	Price, each.	Time for completion.
			Months.		*Months.*		*Months.*
1	Iowa Iron Works, Limited, Dubuque, Iowa..........	$45,490	10	$46,900	10	$46,195.00	10
2	Craig Ship Building Co., Toledo, Ohio..........	49,100	1-6 2-7 1-8	50,986	6	50,475.00	1-6 1-7
3	The Springfield Boiler and Manufacturing Co., Springfield, Ill....	56,075 55,674 56,867	12	58,715 58,715 59,094	8	57,791.00	10
4	Ed. J. Howard, Jeffersonville, Ind..........	....	....	....	....	....	....
5	Edward Flad, St. Louis, Mo..........	63,472	11	68,813	7	64,775.50	9
6	Marietta Boiler Works, Marietta, Ohio..........	....	....	....	....	....	....
7	The Cincinnati Marine Railway Co., Cincinnati, Ohio..........	....	....	....	....	....	....
8	Shook-Anderson Manufacturing Co., Pittsburg, Pa..........	....	....	71,550	12	69,500.00	12
9	Riter-Conley Co., Pittsburg, Pa....	73,900	12	74,400	9	74,150.00	10

Abstract of proposals for furnishing five large steam tenders, received in response to advertisement dated April 27, 1898, etc.—Continued.

No.	Name and address of bidder.	Three tenders (No. 5 and two of Nos. 1, 2, 3, and 4).		Four tenders (No. 5 and three of Nos. 1, 2, 3, and 4).		Five tenders (Nos. 1, 2, 3, 4, and 5).	
		Price, each.	Time for completion.	Price, each.	Time for completion.	Price, each.	Time for completion.
			Months.		*Months.*		*Months.*
1	Iowa Iron Works, Limited, Dubuque, Iowa	$45,793.33⅓	10	$45,717.50	10	$45,672.00	10
2	Craig Ship Building Co., Toledo, Ohio	49,995.00	1-6 2-7	49,947.00	1-6 2-7 1-9	49,280.00	1-6 2-7 2-9
3	The Springfield Boiler and Manufacturing Co., Springfield, Ill.	57,464.33⅓	12	57,051.00	13	56,403.00	18
4	Ed. J. Howard, Jeffersonville, Ind	....	....	....	....	....	....
5	Edward Flad, St. Louis, Mo	64,235.66⅔	10	63,970.75	11	63,809.80	12
6	Marietta Boiler Works, Marietta, Ohio	....	....	....	....	....	....
7	The Cincinnati Marine Railway Co., Cincinnati, Ohio	....	....	....	....	....	....
8	Shook-Anderson Manufacturing Co., Pittsburg, Pa	....	....	....	....	....	....
9	Riter-Conley Co., Pittsburg, Pa.	74,066.66⅔	11	74,025.00	12	74,000.00	13

No.	Name and address of bidder.	Refrigerating plant for each tender (each).	Compound engines. Additional price, each tender.	Remarks.
1	Iowa Iron Works, Limited, Dubuque, Iowa.	....	$3,000	Accepted for 5 tenders with high-pressure engines, at $45,672 each.
2	Craig Shipbuilding Co., Toledo, Ohio	$3,600	6,500	
3	The Springfield Boiler and Manufacturing Co., Springfield, Ill.	3,200	5,000	With engine No. 3; with engine No. 2; with Hegewald & Co. engines.
4	Ed. J. Howard, Jeffersonville, Ind	1,850	....	
5	Edward Flad, St. Louis, Mo	2,250	5,500	
6	Marietta Boiler Works, Marietta, Ohio	700	....	
7	The Cincinnati Marine Rwy. Co., Cincinnati, Ohio.	3,296	....	
8	Shook-Anderson Manufacturing Co., Pittsburg, Pa.	....	....	
9	Riter-Conley Co., Pittsburg, Pa	4,500	5,000 4,000	Surface condenser for compound engine. Jet condenser for compound engine.

Abstract of proposals for furnishing the services of towboats, received in response to advertisement dated May 25, 1898, and opened by Capt. H. E. Waterman, Corps of Engineers, June 24, 1898.

No.	Name of bidder.	Name of steamer.	Rate per day.	
			For period of thirty days or more.	For period less than thirty days.
1	B. B. Bradley *a*	Fred Hartweg	$40.00	$50.00
2	Oscar F. Barrett	John Barrett Charley McDonald	25.00 40.00	25.00 40.00
3	Huse & Loomis Ice and Transportation Co	Jack Frost Polar Wave	40.00 35.00	60.00 50.00
4	W. J. Wood *a*	Beaver	45.00	75.00
5	Frederick Hartweg *a*	H. F. Frisbie	48.00	58.00
6	The McKinley Coal Co. *a*	Tom Rees No. 2	48.75	48.75
7	Mississippi River and Bonne Terre Transportation Co.	Eagle	50.00	60.00
8	O. A. Douds, M. H. McDonald, Frank A. Bailey	Hornet No. 2	35.00	60.00
9	C. Jutte & Co	Raymond Horner Defender	80.00 80.00	80.00 80.00
10	Kate L. Honshell, William Bay, L. D. Davis	George Wood	40.00	(*b*)
11	The Michael Transportation Co	Mary M. Michael	27.00	30.00

a Recommended for award.

b $30 per day for sixty days or more.

IMPROVING MISSISSIPPI RIVER, SECRETARY'S OFFICE.

List of contracts entered into by Capt. H. E. Waterman, Corps of Engineers, in force June 30, 1898.

Contract for—	Contractor.	Date of contract.	Date of approval.	Date of beginning work.	Date of expiration of contract.
Alterations to hull of dredge Beta. [a]	Iowa Iron Works, Limited.	Feb. 14, 1898	Apr. 1, 1898	Feb. 24, 1898	May 14, 1898
Coal	Frederick Hartweg	Mar. 28, 1898	June 10, 1898	July 1, 1898	June 30, 1899
Boilers for steamer Mississippi.	John O'Brien Boiler Works Co.	Apr. 15, 1898	June 16, 1898	Apr. 25, 1898	July 14, 1898
Four pile sinkers	The Cincinnati Marine Railway Co.	Apr. 25, 1898	.....do	May 5, 1898	July 24, 1898
Three steam tenders	M. A. Sweeney Co	.....do	.....do	.....do	Sept. 10, 1898

[a] Work not completed.

Statement of maps and charts issued and sold from July 1, 1897, to June 30, 1898.

Description.	Free.	Sold.	Total.
Upper alluvial valley map	2	2	4
Lower alluvial valley map	....	316	316
Inch to mile map	1,730	865	2,595
Detail chart, 1:20,000 scale	2,301	402	2,703
Detail chart, 1:10,000 scale (harbor of New Orleans)	600	20	620
District map of Lower Mississippi River	176	6	182
Total	4,809	1,611	6,420

Proceeds deposited with assistant treasurer of the United States at St. Louis, Mo., $171.32.

List of civilian engineers employed on works of the Mississippi River Commission in charge of Capt. H. E. Waterman, Corps of Engineers, secretary, from July 1, 1897, to June 30, 1898.

Name and residence.	Time employed.		Pay per month.	Where employed.	Work on which employed.
	Mos.	*Dys.*			
J. A. Ockerson, St. Louis, Mo.	10	18	$250	Secretary's office	In charge of surveys, gauges, and observations.
Thos. Middleton, St. Louis, Mo.	12	0	200	.....do	In charge of designing and construction of plant.
Jas. A. Seddon, St. Louis, Mo.	2	10	200	.....do	Reports and physical data.
A. T. Morrow, Rockford, Ill.	12	0	175	In field and secretary's office.	Surveys.
Kivas Tully, St. Louis, Mo.	12	0	175	Secretary's office	Computing division.
C. W. Clark, Webster Groves, Mo.	12	0	175	.....do	Mapping division.
E. H. Twining, New York, N. Y.	12	0	175	President's office	Reports and estimates.
W. G. Comber, Benton, Mo	12	0	150	In field and secretary's office.	Surveys.
C. W. Sturtevant, Appleton, City, Mo.	1	0	150	In field	In charge of dredging operations.
Do	7	0	175	.....do	Do.
Do	4	0	200	.....do	Do.
Geo. H. French, Beuton, Mo.	2	0	145	In field and secretary's office.	Surveys.

Approximate value of plant belonging to the United States used on works under the Mississippi River Commission, in charge of Capt. H. E. Waterman, Corps of Engineers, secretary.

Class of property.	Present approximate value.	Class of property.	Present approximate value.
Dredge Alpha	$54,000	Steamboat Vidalia	$2,000
Dredge Beta	175,000	Barges	12,000
Dredge Gamma	80,000	Pile sinkers	7,500
Dredge Delta	100,000	Survey and quarter boats	3,000
Dredge Epsilon	105,000	Flatboats and skiffs	1,200
Dredge Zeta	105,000	Diving outfit	300
Steamboat Mississippi	50,000	Surveying instruments, photographic outfit, office furniture, books, etc	7,000
Steamboat Minnetonka	12,000		
Steamboat Patrol	10,000		
Steamboat Search	7,000	Total	732,000

APPENDIXES ACCOMPANYING THE REPORT OF CAPT. H. E. WATERMAN, CORPS OF ENGINEERS, SECRETARY MISSISSIPPI RIVER COMMISSION.

A. Laws affecting the Mississippi River Commission, July 1, 1897, to June 30, 1898, inclusive.

B. Specifications for alterations to the hydraulic dredge *Beta* and for the construction of 4 pile sinkers, 3 small tenders, and 5 large tenders.

C. Report of Assistant Engineer J. A. Ockerson on office work, surveys, and collection of physical data.

D. Report of Assistant Engineer Thomas Middleton on construction, alteration, and repairs to plant.

E. Report of Assistant Engineer C. W. Sturtevant on care and repair of plant in the field, testing of new plant, and dredging operations on the Lower Mississippi River between Cairo, Ill., and the Head of the Passes, Louisiana.

F. Report of Assistant Engineer C. W. Sturtevant on tests of U. S. dredge *Alpha*.

LIST OF PLATES ACCOMPANYING THE ANNUAL REPORT OF CAPT. H. E. WATERMAN, CORPS OF ENGINEERS, SECRETARY MISSISSIPPI RIVER COMMISSION, FOR FISCAL YEAR ENDING JUNE 30, 1898.

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APPENDIX 1 A.

LAWS AFFECTING THE MISSISSIPPI RIVER COMMISSION, JULY 1, 1897, TO JUNE 30, 1898.

[Copies of previous laws will be found in the Annual Reports of the Mississippi River Commission for 1889, 1895, and 1897.]

AN ACT Making appropriations to supply deficiencies in the appropriations for the fiscal year ending June thirtieth, eighteen hundred and ninety-seven, and for prior years, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and the same are hereby, appropriated, out of any money in the Treasury not otherwise appropriated, to supply deficiencies in the appropriations for the fiscal year eighteen hundred and ninety-seven, and for prior years, and for other objects hereinafter stated, namely:

* * * * * * *

WAR DEPARTMENT.

* * * * * * *

RIVERS AND HARBORS.

IMPROVING MISSISSIPPI RIVER: For continuing improvement of Mississippi River from Head of the Passes to the mouth of the Ohio River, six hundred and twenty-five thousand dollars.

* * * * * * *

Approved July 19, 1897.

APPENDIX 1 B.

SPECIFICATIONS FOR ALTERATIONS TO THE HYDRAULIC DREDGE BETA, AND FOR THE CONSTRUCTION OF 4 PILE SINKERS, 3 SMALL TENDERS, AND 5 LARGE TENDERS.

SPECIFICATIONS FOR ALTERATIONS TO HULL OF UNITED STATES DREDGE BETA.

1. *General.*—The work contemplated under these specifications is the making of certain alterations and additions to the hull of the U. S. dredge *Beta*, for the purpose of reducing the present draft to forty-eight (48) inches. It is intended, therefore, to add nine (9) feet in width to each side of the boat, to extend wing pieces forward from the present bow, connecting the same by a girder; and to extend and alter the stern, all as shown in general and in detail on Drawings $\frac{\text{M. R. C.}}{1034}$, sheets 9, 12, 13, and 14, and as hereinafter specified.

2. *Material.*—The material used for this work shall be mild steel, having an ultimate tensile strength of from 52,000 to 62,000 lbs. per square inch, an elastic limit of not less than one-half the ultimate strength, with a minimum elongation of twenty-five (25) per cent in an original length of eight inches. It must be able to stand being bent cold to 180° flat upon itself without showing any signs of fracture upon the outside of the bent portion. Finished bars must be free from injurious seams, flaws, or cracks, and have a workmanlike finish. All rivets to be Burden's best, or others of equal quality, and shall be tested cold by driving the shank into the head without showing any signs of fracture. All tests and inspection will be made at the place of manufacture before shipment, by inspectors appointed by the engineer officer in charge, and one test piece for tensile strength and one for bending shall be taken from the steel of each heat. A variation in the weights of material of 2¼ per cent above or below that specified will be allowed. The contractor must provide facilities for the making of all these tests at his own expense.

3. *Side extensions.*—The side extensions will be nine feet wide on each side of present hull and will run all fore and aft, working into the bow wings and the new stern at the ends. They will be built with a dead rise of one inch, and will be divided into water-tight compartments, all as shown on sheets 12, 13, and 14, $\frac{\text{M. R. C.}}{1034}$. A stringer of 4″ × 3″ × 8.5 lb. angle bars will extend along each side of hull flush with present knuckle, and will be riveted through plate and knuckle with ¾-inch

rivets; the present rivets to be drilled out and holes enlarged for this purpose. As the sides of present hull are constructed without side butt straps the stringers will have to be jogged over them, and consequently can not be worked until accurate templets are taken from the dredge. Floor beams are to be 5" × 11.6 lb. Z bars, spaced 24 inches apart, and in the position shown on sheet No. 14, $\frac{\text{M. R. C.}}{1034}$, with relation to framing of present hull, and will be jogged to fit over stringers and secured to sides of hull by gusset plates ¼ inch thick and by 2½" × 2½" × 5 lb. angles. The frames will be of 4" × 3" × 8½ lb. angle bars, spaced 24" apart to coincide with floor beams, to which they will be attached by gusset plates ¼" thick. The deck beams will be 4" × 3" × 8.5 lb. angle bars, and will be attached to frames by gusset plates, and to hull by gusset plates and angles.

4. *Knuckles and gunwales.*—Both knuckles and gunwales will be 3" × 3" × 8.3 lb. angle bars joined together by angle splice pieces not less than 24" long and ½" thick. The gunwale angle will be placed on the outside of plating, except on the inboard side and ends of bow wings, where it will be placed on the inside of plating.

5. *Bulkheads.*—There will be six (6) water-tight bulkheads in each side extension at a distance of thirty (30) feet apart, and one (1) collision bulkhead in each bow wing. These will be made of ¼" plate attached to bottom plates by 3" × 3" × 8.3 lb. angle bars, jogged over knuckle and stringer bars, and will be strengthened by channel and angle bars as shown on sheet No. 13. The bulkhead plates will have butt joints at center, with double strap single riveted, the channel bar stiffener forming the strap on one side.

6. *Bracing.*—The extension sides will be strengthened by stanchions and diagonals riveted to each floor and deck beam, as shown on sheet No. 14, $\frac{\text{M. R. C.}}{1034}$. At every third frame the stanchion will be a 6" × 8 lb. channel bar secured directly to floor by four (4) ⅝" rivets and to deck beam by gusset plate with six (6) ⅝" rivets. A diagonal of 8" × 11 lb. channel bar will extend from knuckle corner of new side to gunwale corner of old hull and will be riveted to gusset plates at ends and to stanchion in the middle. The intermediate stanchions will be 5" × 6.5 lb. channel bars, secured to floor and deck beams in the same manner as described above.

7. *Bow wings.*—These wings will overlap the bow of dredge inboard, a distance of two feet on each side, leaving a clear space of thirty-six (36) feet between. They will extend forward for thirty-six (36) feet, and will be shaped as shown on plan sheet No. 12, $\frac{\text{M. R. C.}}{1034}$, being widened at the ends to a distance of forty-two (42) feet between. The framing will be similar to and a continuation of that for the extension sides. The inboard side connection to present hull must be very strongly and carefully made in the manner indicated on sheet No. 13, $\frac{\text{M. R. C.}}{1034}$. The collision bulkhead will be placed on frame "M," and from thence forward the floors will consist of 3"×3"× 8.3 lb. angle bars connected to frames by gusset plates. The two wings will be connected at the bow by a girder three feet wide and three feet deep, constructed as shown in detail on sheet No. 13, $\frac{\text{M. R. C.}}{1034}$. There will be two bars of 7"×3½"×19 lb. angles riveted to and extending all across the bow, which will be perforated with holes at 8" centers of a size to take the screen bars. These screen bars are to be made of 3" extra heavy pipe 2 feet 9 inches long, and held in place by pins ¾" diameter placed near one end and projecting ¾" on each side.

8. *Stern.*—The poop deck on the present hull is to be cut down flush with the main deck, and a portion of the present stern plates and floor beams removed, and the hull prepared for the extension of stern on the new lines as shown on sheets Nos. 12 and 13, $\frac{\text{M. R. C.}}{1034}$. The wells for anchor and push spuds at present in the boat must be removed, and the plating and floors of the well holes not replaced by the new stern must be made good. The transverse through floors will terminate with No. 82, and the keelsons must be cut flush with the aft edge to this floor. From this point the rake of stern will be framed longitudinally. The floors must be 4"× 3"× 8½ lb. angle bars, and will be jogged over bottom flange of floor No. 82 and continued up to gunwale at the stern to form the stern frames. They will be further connected to floor No. 82 and keelsons by gusset plates and angles, as shown on sheet No. 13, $\frac{\text{M. R. C.}}{1034}$, and will be stiffened by reverse frames each of 2½"× 2½"× 5 lb. angle bars. In the side extensions the transverse floor beams will be continued throughout, but at No. 83 they will change from Z bars to 4"× 3"× 8.5 lb. angle bars, which will be connected to frames by gussets and angles of the same strength and in the same manner as before described. The deck beams will be similar to those in extension

sides. as far as frame No. 82, and the remainder will run through from side to side. The deck plating of poop will be removed in one piece by the United States in order to remove filters and piping now located in the stern, and it is expected that a portion of this deck can be used again, as indicated on sheet No. 12, $\frac{\text{M. R. C.}}{1034}$. The deck must be efficiently supported by an ample number of stanchions of channel or angle bars, as may be required.

9. *Plating.*—The butts of plating shown on sheet No. 12, $\frac{\text{M. R. C.}}{1034}$, are arranged to conform with those of the original hull, which are also indicated on said drawing. If he prefers, however, the contractor may use three strakes in bottom and deck if the plates are made thirty-two (32) feet long instead of sixteen (16) feet. The bottom strake next to present hull will be of 12.75 lb. plate, and top strake of sides to below water line will be the same thickness. The plates of rake at bow will be 15.3 lbs. and all plates on inboard sides of bow wings will be 10.2 lb. Doubling plates 10.2 lb. will be placed on side plates where the connection to bow of old hull is made. The remainder of plating will be 10.2 lb., except where otherwise specified or noted on drawings. The top strake of side plating will be the outside course, and fillers 3" × ½" will be used between plate and frames. The bottom and deck course may be laid to frames without fillers.

10. *Tie plate.*—A tie or lap plate for the additional strengthening of the connection between new and old parts of hull will be riveted on bottom over the old knuckle and new stringer angles. This plate will run all fore and aft of old hull and will be about 12½" wide × 15.3 lb., and will be riveted by a row of ¾" rivets on each edge and entirely outside of the knuckle and stringer rivets which it will cover. The rivets on edge of plate attached to new sides will be 4-inch centers, but those on edge attached to present hull will have to be determined by examination and made to work in with existing rivet system. Both old and new plates at this part must be thoroughly well calked and the space between angles and plates filled in with cement before the tie plate is riveted on.

11. *Joints and riveting.*—The longitudinal joints of plating will be single-riveted lap 2½" wide. All transverse joints will be butted, with inside straps 7½" wide and double riveted. Butt straps to be ⅛" thicker than the plates which they connect, and the butts of all plates to be planed and fitted close, metal to metal. The general run of rivets throughout the hull to be ⅝" diameter, and those for all outside work to be countersunk and driven flush or slightly rounded. Rivets of ¾" diameter will, however, be used to secure stringer angles and tie plates, as before described, and also in other special parts where marked on drawings or the nature of the work requires. The rivet spacing to be in accordance with the rules of the American Shipmasters' Association.

12. *Spud wells, etc.*—One of the spud wells which will be taken out of stern is to be placed in bow between frames Nos. 5 and 6. The necessary holes in deck, floor, and bottom are to be cut, and any other work required for altering, placing, and securing the well in the new position is to be done by the contractor. There will also be required a seat for spud-lifting cylinder, which is to be made of plates and angles as shown on sheet No. 14, $\frac{\text{M. R. C.}}{1034}$, and well riveted to inside bottom plates, keelson, and bulkhead.

13. *Main-pump discharge pipes.*—These pipes, which run from pumps to and out of stern, are to be placed between boilers and on the floor of hold, as shown on sheet No. 9, $\frac{\text{M. R. C.}}{1034}$. The four bends which make connection to the pumps are to be made from templets and properly shaped to suit the position indicated, and must be made of steel plate 5/16" thick and of small segments, in order that the finished pipes shall have as regular a curve and present as neat an appearance as possible. The flanges must be faced, and may be of cast iron, similar in section to those on the other pipes. The inner bottom plates are to be cut to allow bends to drop below water line, and will have an angle-iron coaming fitted around them, riveted to inner bottom, and made water-tight by filling in with Portland or other cement satisfactory to the engineer officer in charge. The several lengths of pipe now on board will be nearly sufficient to complete the distance to stern, but they will have to be adjusted in lengths, the angled flanges cut off and riveted on square with pipe, and otherwise made to fit their new position, and be fitted in place in a thoroughly good and workmanlike manner. The holes at stern of dredge through which the discharge pipes pass must be made good by suitable flanges worked from 5/16" steel plate and well riveted to hull and pipes. All riveting of these pipes must be flush inside. The discharge pipes pass through bunker and bulkhead No. 78, and the necessary holes must be cut and bulkheads made water-tight with angle-iron rings calked in with lead filling.

14. *Capstan beds.*—Three steel plates $\frac{5}{16}$″ thick are to be riveted to floors of bow wings and stern in the position shown on sheet No. 12, $\frac{\text{M. R. C.}}{1034}$, and holes cut in deck for capstan shafts.

15. *Hatches and ladders.*—Hatchways are to be cut for access to all compartments of additions to hull, located as shown or as may be hereafter determined. The smaller hatches are to be fitted with cast-iron frames, gratings, and covers; the larger ones in bow wings, and at stern to have plate steel covers ⅛″ thick, stiffened with 1½″×1½″×$\frac{3}{16}$″ angle bars. Each compartment will be provided with an iron ladder 13″ wide, the side bars to be 1½″×¼″, and the rungs of ⅝″ round iron placed about 10″ apart. All ladders will be secured in place at their respective hatches. A manhole must be made in each collision bulkhead, the plates to be stiffened with rings of 1½″×¼″ iron and to be provided with doors and fastenings.

16. *Ash pipes.*—Four ash pipes will be supplied, the necessary holes cut in the hull and the pipes properly secured and made water-tight to both inner and outer bottoms. The pipes are to be made of 12″ boiler tube with hoppers on top, provided with doors and cross bars for securing the same, all as shown on sheet No. 13, $\frac{\text{M. R. C.}}{1034}$. Flanges of 2½″×2½″×$\frac{5}{16}$″ angle bar will be used for securing pipes to hull, and the inner bottom will be made water-tight by flanges of 2″×2″×¼″ angle bar, to be calked in around pipes with lead or rust.

17. *Bitts, chocks, etc.*—The bitts, chocks, and kevils at present on dredge are to be removed, and the full number shown on sheet No. 9, $\frac{\text{M. R. C.}}{1034}$, placed on new deck in locations indicated. The old ones that can be used again are: Four large bitts, four pair of sheave chocks, two large kevils, and two small kevils. The following new ones will have to be supplied: Two pairs of sheave chocks similar to those now in use on board, and twelve large kevils at least four feet long and of heavy pattern. All bitts, chocks, and kevils must have under them stiffening plates ¼″ thick riveted to deck and deck beams. The davit now at the stern of the dredge is to be placed on the new stern and another one of the same size supplied and put in shape as shown.

18. *Nosing.*—The oak nosing on present hull is to be removed and may be used again if found in good condition. It must be taken off of the old hull and put on the new hull by the contractor, and all new nosing required, as well as bolts, must be furnished.

19. *Addition to bunker.*—The forward bunker will be dispensed with and a portion of the plating removed by the United States. This will be cut out in one piece, if practicable, and will be transferred to the bunker between the boilers. The contractor will be required to place and secure this piece as an addition to the present bunker, and must supply any plate or angles, etc., that may be required to complete the same as shown on general drawing, sheet No. 9, $\frac{\text{M. R. C.}}{1034}$.

20. *Work on present hull.*—The work on the hull of the dredge directly connected with the additions and alterations, as hereafter specified, must be done by the contractor at his expense, and shall be included in and form part of the contract under this specification and drawings. This work will in the main consist of the following items, but each intending bidder must satisfy himself as to the method of doing the work, the construction of the present hull, and all other points involved in the proposed changes:

(*a*) Removal of certain plates at stern and the cutting and preparation of keelson beams and plates ready for new work.

(*b*) Cut down the stern bulkhead and the two side plates that will be retained to the level of the main deck.

(*c*) Remove the corner gussets in the stern compartment. (The new deck will take the place of these gussets.)

(*d*) Prepare the old poop deck for addition if contractor wishes to use any part of it.

(*e*) Drill or punch, as may be required, all holes necessary for the attachment of new work.

(*f*) Cut all holes in bulkheads and floor required for the discharge pipes.

(*g*) Cut holes for the ash pipes.

(*h*) Remove the spud wells at the stern and make good the recess for push spud which is not covered by the new stern.

(*i*) Cut holes in the deck and bottom required for the new spud well.

(*j*) Cut manholes in the water bottom to give access to the bilges where the new work is connected to the old and provide and fit in place suitable doors for making these holes water-tight.

21. For the purpose of doing the above-described work the U. S. dredge boat will

be taken by the United States from her present winter quarters at New Madrid, Mo., as early as practicable to Keokuk, Iowa, and docked at the Government dry dock at that point. During the existence of the contract other necessary work will be carried on by the United States, which will not interfere with the work of the contractor, and the engineer officer in charge will be entitled to decide as to whether any such interference exists.

The following work will be done by the United States without expense to the contractor:

(*a*) The docking and blocking of the dredge in the first instance at the Government dock at Keokuk, Iowa; but this will not include the cost of such blocking as may be required by the contractor for the support of the new parts to be added to the dredge.

(*b*) The removal of such machinery and piping as can be readily taken down where it interferes seriously with the performance of the contractors' work; but the determination as to what machinery shall be thus removed will rest entirely with the engineer officer in charge or such authorized agent as he may appoint to act for him.

(*c*) Removal of all machinery which is to be discarded or changed, including the spud anchors.

22. Bidders, or their authorized agents, must visit the locality where work is to be done and make their own estimates of the facilities and difficulties attending the execution of the work, including the uncertainty of weather and all other contingencies. Due notice will be given beforehand as to when the docking will be completed, and the contractor will be required to commence the work proper on the dredge at once. Until the boat can be moved up the river it may be inspected at the winter quarters near New Madrid, Mo.

23. The contractor will not be allowed to take advantage of any error or omission in these specifications, as full instructions will always be given should an error or omission be discovered.

24. The decision of the engineer officer in charge as to quality or quantity or as to the interpretation of the meaning of these specifications shall be final.

25. The quantities given are approximate only, and no claim shall be made against the United States on account of any excess or deficiency, absolute or relative, in the same. Bidders are expected to examine the drawings and are invited to make estimates of quantities for themselves.

26. The contract price is to be full compensation for furnishing all the materials, labor, and appliances requisite and necessary for doing the work specified. No claim for extra work or material or for delay of any kind will be considered or paid for unless previously authorized in writing by the engineer officer in charge.

27. The contractor will be required to furnish at the dock all the necessary machinery, tools, and labor for promptly pushing the work to conclusion.

28. Work under these specifications must be begun within ten (10) days from the date of notification of award of contract, and must be completed within three (3) months from date of said notification. During this period the work must at all times be pushed at a rate of progress satisfactory to the engineer officer in charge, and if such is not the case, the contractor will be notified and required to supply the necessary extra labor and appliances needed to hurry up the work. If after such notification he should fail to respond promptly and satisfactorily in the opinion of the engineer officer in charge, the contractor will be considered as having failed to comply with the requirements of these specifications according to their real intent and meaning, and the engineer officer in charge will have the right to complete the entire work, or any part thereof, either by contract, days labor, open purchase, or by any other method that he may deem most advantageous to the Government, and the contractor will be charged with any expense thus incurred by reason of his failure to carry out the provisions of these specifications, and the amount of the expense thus incurred will be deducted from any moneys due or which may become due the contractor.

29. All material and workmanship must be of the best quality and will be subject to careful inspection before acceptance by the engineer officer in charge or his authorized agents. The engineer officer in charge shall have the right to require the immediate removal of any employee of the contractor whom he may deem incompetent or otherwise objectionable.

Before removing the boat from the dock the compartments will be required to withstand a water test made under the direction of the engineer officer in charge.

30. The bidder to whom award is made will be required, if the Chief of Engineers, U. S. Army, so directs, to enter into a written contract with the United States, with good and approved security, in an amount of not less than twenty-five (25) per centum of the total amount of the contract within ten (10) days after being notified of the acceptance of his proposal. The contract to be entered into will be, in its general provisions, in the form adopted and in use by the Engineer Department of

the Army, blank forms of which can be inspected at this office and will be furnished if desired to intending bidders. Parties making bids are to be understood as accepting the terms and conditions contained in such form of contract. If a bond is required, it will be subject to all existing laws and regulations applicable. The sureties will make and subscribe affidavits of justification on the back of the bond to the contract, and they must jointly justify in double the amount of the penalty.

31. Payments will be made monthly by the engineer officer in charge upon his estimates of the value of the work done. These estimates will only include the value of the material delivered, ready for erection, on the ground at the Government dock at Keokuk, Iowa, and of the work actually completed and in place in the hull. In case, however, the engineer officer in charge should deem the rate of progress unsatisfactory for the completion of the work within the time allowed, payments will be immediately suspended. A percentage of fifteen (15) per centum will be retained from each payment until the completion of the contract.

32. All parts paid for will become thereby the sole property of the United States; but this provision shall not be interpreted as relieving the contractor from the sole responsibility for the proper care and protection of said part or parts, or from any other of the requirements of these specifications.

33. *Painting.*—All angles, channels, and Z bars; all butt straps and laps of plate, etc., which come in contact must have a coat of pure red lead and boiled linseed oil before being put together; and all the new work, as it is finished, will receive one coat of same kind and quality of paint; and when all is finished, tested, and approved, the outside will receive two more coats of same grade of paint up to water line, and from water line up to and including the nosing the outside will receive two coats of pure white lead and boiled linseed oil toned to lead color.

IMPROVING MISSISSIPPI RIVER.—ADVERTISEMENT, INSTRUCTIONS, SPECIFICATIONS, PROPOSAL, ETC., FOR FOUR PILE SINKERS, FOR MISSISSIPPI RIVER COMMISSION.

ADVERTISEMENT.

PROPOSALS FOR STEAM TENDERS AND PILE SINKERS.—Mississippi River Commission, 2732 Pine st., St. Louis, Mo., March 14, 1898.—Sealed proposals, in triplicate, for furnishing three small steam tenders and four pile sinkers will be received here until 12 o'clock noon, standard time, April 14, 1898, and then publicly opened. Information furnished on application. H. E. WATERMAN, Capt. Eng'rs, Sec'y.

SPECIFICATIONS.

GENERAL INSTRUCTIONS FOR BIDDERS.

1. The attention of bidders is especially invited to the acts of Congress approved February 26, 1885, and February 23, 1887, as printed in vol. 23, page 332, and vol. 24, page 414, United States Statutes at Large, which prohibit the importation of foreigners and aliens, under contract or agreement, to perform labor in the United States or Territories or the District of Columbia.

2. Preference will be given to articles or materials of domestic production, conditions of quality and price being equal, including in the price of foreign articles the duty thereon.

3. Bidders, or their authorized agents, are expected to visit the localities referred to and to make their own estimates of the facilities and difficulties attending the execution of the work, including the uncertainty of weather and all other contingencies.

4. No proposal will be considered unless accompanied by a guaranty in manner and form as directed in these instructions.

5. All bids and guaranties must be made in triplicate upon printed forms to be obtained at this office.

6. The guaranty attached to each copy of the bid must be signed by two responsible guarantors, to be certified as good and sufficient guarantors by a judge or clerk of a United States court, a United States district attorney, a United States commissioner, or a judge or clerk of a State court of record, with the seal of said court attached.

7. A firm as such will not be accepted as surety, nor a partner for a copartner or firm of which he is a member. Stockholders who are not officers of a corporation may be accepted as sureties for such corporation. Sureties must be citizens of the United States.

8. Each signature to guaranties and bonds shall have affixed to it an adhesive seal. All signatures to proposals, guaranties, contracts, and bonds should be written out

in full, and each signature to guaranties, contracts, and bonds should be attested by at least one witness, and, when practicable, by a separate witness to each signature.

9. Each guarantor will justify in the sum of twenty (20) per centum of the amount of the bid. The liability of the guarantors and bidder is determined by the act of March 3, 1883, 22 Statutes, 487, chap. 120, and is expressed in the guaranty attached to the bid.

10. A proposal by a person who affixes to his signature the word "president," "secretary," agent," or other designation, without disclosing his principal, is the proposal of the individual. That by a corporation should be signed with the name of the corporation, followed by the signature of the president, secretary, or other person authorized to bind it in the matter, who should file evidence of his authority to do so. That by a firm should be signed with the firm name, either by a member thereof or by its agent, giving the names of all members of the firm.

11. The place of residence of every bidder and post-office address, with county and State, must be given after his signature.

12. All prices must be written as well as expressed in figures.

13. One copy each of the advertisement, the instructions for bidders, and the specifications, all of which can be obtained at this office on application by mail or in person, must be securely attached to each copy of the proposal and be considered as comprising a part of it.

14. Proposals must be prepared without assistance from any person employed in or belonging to the military service of the United States or employed under this office.

15. No bidder will be informed, directly or indirectly, of the name of any person intending to bid or not to bid or to whom information in respect to proposals may have been given.

16. Anyone signing the proposal as the agent of another or others must file with it legal evidence of his authority to do so.

17. All blank spaces in the proposal and bond must be filled in, and no change shall be made in the phraseology of the proposal, or addition to the items mentioned therein. Any conditions, limitations, or provisos attached to proposals will be liable to render them informal, and cause their rejection.

18. Alterations by erasure or interlineation must be explained or noted in the proposal over the signature of the bidder.

19. If a bidder wishes to withdraw his proposal, he may do so before the time fixed for the opening, without prejudice to himself, by communicating his purpose in writing to the officer who holds it, and, when reached, it shall be handed to him or his authorized agent, unread.

20. Reasonable grounds for supposing that any bidder is interested in more than one bid for the same item will cause the rejection of all bids in which he is interested.

21. No bids received after the time set for opening of proposals will be considered.

22. The proposals and guaranties must be placed in a sealed envelope marked "Proposals for pile sinkers," and inclosed in another sealed envelope addressed to Captain H. E. Waterman, Corps of Engineers, U. S. A., secretary Mississippi River Commission, 2732 Pine street, St. Louis, Mo.

23. The United States reserves the right to reject any and all bids, and to waive any informality in the bids received; also to disregard the bid of any failing bidder or contractor known as such to the Engineer Department.

24. The bidder to whom award is made will be required to enter into written contract with the United States, with good and approved security, in an amount of twenty (20) per centum of the total amount of the contract, within ten (10) days after being notified of the acceptance of his proposal.

25. The contract which the bidder and guarantors promise to enter into shall be, in its general provisions, in the form adopted and in use by the Engineer Department of the Army, blank forms of which can be inspected at this office, and will be furnished if desired to parties proposing to put in bids. Parties making bids are to be understood as accepting the terms and conditions contained in such form of contract.

26. The sureties are to make and subscribe affidavits of justification on the back of the bond to the contract and they must jointly justify in double the amount of the penalty.

27. Bidders are invited to be present at the opening of the bids.

GENERAL CONDITIONS.

28. A copy of this advertisement, specifications, and instructions will be attached to the contract and form a part of it.

29. The contractor should, within ten (10) days from the award of the contract, furnish this office with the post-office address to which communications should be sent.

30. Transfers of contracts, or of interests in contracts, are prohibited by law.

31. The contractor will not be allowed to take advantage of any error or omission in these specifications, as full instructions will always be given should such error or omission be discovered.

32. The decision of the engineer officer in charge as to quality and quantity, and as to the interpretation of these specifications, shall be final.

33. It is understood and agreed that the quantities given are approximate only, and it must be understood that no claim shall be made against the United States on account of any errors, excess or deficiency, absolute or relative, in the same. Bidders are expected to examine the drawings, and are invited to make the estimate of quantities for themselves.

34. Payment will be made for each pile sinker when delivered and accepted.

35. Should the time for the completion of the contract be extended, all expenses for inspection and superintendence during the period of the extension, the same to be determined by the engineer officer in charge, shall be deducted from payments due or to become due to the contractor: *Provided, however*, That if the party of the first part shall, in the exercise of his discretion, because of freshets, ice, or other force or violence of the elements, allow the contractor additional time in writing as provided for in the form of contract, there shall be no deduction for the expenses for inspection and superintendence for such additional time so allowed: *Provided further*, That nothing in these specifications shall affect the power of the party of the first part to annul the contract as provided for in the form of contract adopted and in use by the Engineer Department of the Army.

DETAILED SPECIFICATIONS.

36. *Work specified.*—The work to be contracted for under these specifications shall comprise all the labor and material necessary for the construction and delivery of four pile sinker hulls with leads, but without cabins, machinery, or boilers.

37. *Dimensions.*—The length of the hull is to be seventy-six (76) feet, beam twenty-five (25) feet, and the depth of sides three (3) feet ten (10) inches to top of gunwale. The deck is to have a crown of four (4) inches and both ends of hull to have a short rake; all as shown on drawing $\frac{\text{M. R. C.}}{665}$, sheet 5.

38. *Material.*—All materials to be the best of their kinds. The timber must be free from sapwood, shakes, large and loose knots, and also from large wanes, and must be dressed where usual for this class of work.

39. *Gunwales.*—The gunwales will be of Oregon fir or long-leaf yellow pine. All strakes to be in one length unless otherwise authorized by the engineer officer in charge. Strakes must be fastened with drift bolts of three-quarter (¾) inch square iron, spaced six (6) feet apart, the bolts securing the third strake to go halfway into the knuckle and those securing the fourth strake to go halfway into the second; thus making the final distance apart of bolts two (2) feet. The seams must be outgauged for caulking and the knuckle rebated two and one-half (2½) inches by five (5) inches for planking.

40. *Bulkheads.*—There will be two fore-and-aft bulkheads, spaced six (6) feet on each side of the center line, made of white pine or poplar, in long lengths, scarfed and bolted in the same manner as the gunwales, but with five-eighths (⅝) inch square iron. Limber holes one (1) inch by four (4) inches to be cut about every six (6) feet at lower edge of bulkheads.

41. *Floor stringers.*—Five floor stringers of white oak, four (4) inches by six (6) inches, will run all fore and aft. They must be scarfed not less than thirty (30) inches, with limber holes as in bulkheads.

42. *Rake timbers.*—These must be white oak shaped to rakes, tenoned at top to receive head block and scarfed to floor stringers.

43. *Head blocks.*—These will be of long-leaf yellow pine, well bolted to gunwales and rake timbers.

44. *Shoes or rake corners.*—These must be of white oak, properly scarfed and secured to gunwales and head blocks and rebated for planking.

45. *Planking.*—The planking will be of white oak, two and one-half (2½) inches thick, dressed on one side and both edges, outgauged for caulking, and secured to all fastenings by five (5) inches by one-quarter (¼) inch spikes. Holes must be bored for spiking.

46. *Deck beams.*—These will be of Oregon fir or long-leaf yellow pine, three (3) inches by six (6) inches, spaced twenty-four (24) inches apart, center to center. They will be half checked into and bolted to gunwales with one-half (½) inch drift bolts.

47. *Stanchions.*—These will be of best yellow pine, three (3) inches by four (4) inches, placed under alternate beams and on alternate stringers, and be well nailed with wire nails at top and bottom.

48. *Plank-sheer.*—This will be of white oak, two (2) inches by ten (10) inches,

scarfed together with scarfs not less than thirty (30) inches long, and spiked to beams and gunwales.

49. *Decking.*—This will be of white pine, well seasoned, dressed on one side and on both edges, to be two (2) inches thick after dressing. The strakes will be not more than six (6) inches wide, outgauged for caulking and nailed to each and every beam with 20d. wire nails, the heads punched in below surface of deck and filled.

50. *Timber heads.*—Four (4) pairs of timber heads of white oak, six (6) inches by eight (8) inches will be placed as shown on drawing $\frac{\text{M. R. C.}}{665}$, sheet 5, and will be securely bolted to gunwales with three-quarter ($\frac{3}{4}$) inch screw bolts.

51. *Nosing.*—A nosing of white oak, two (2) inches by six (6) inches, will run all around the hull, except between the leads, where a steel plate one-quarter ($\frac{1}{4}$) inch thick and twenty (20) inches wide, extending three (3) inches on deck, and eighteen (18) inches under rake, must be securely fastened with one-half ($\frac{1}{2}$) inch bolts, of which as many as possible must be screw bolts.

52. *Pump well.*—A well about twenty-four (24) inches square will be put through the bottom of the hull, extending to the deck, as indicated on drawing $\frac{\text{M. R. C.}}{665}$, sheet 5. This will be made a thoroughly good job and very well fastened to the starboard bulkhead.

53. *Hatches.*—The necessary hatchways will be cut in the deck and fitted with coamings and covers.

54. *Corner straps.*—A strap or band of iron, five (5) inches by one-half ($\frac{1}{2}$) inch, will be fitted on each corner of hull and secured by screw and drift bolts. The ends of bands must be well chamfered and the bolt heads flush. The straps will extend three (3) feet in each direction.

55. *Caulking.*—The seams of bottom planking will be well filled with oakum and tightly horsed up, with a heavy thread of oakum laid in on top. The sides will have two (2) heavy threads of oakum well laid in. The deck will have one (1) thread of cotton and one (1) heavy thread of oakum. The seams of hull will be payed with red lead and the deck with white lead, all thoroughly laid in.

56. *Leads.*—The leads will be forty-four (44) feet high and built of first-class long-leaf yellow pine, dressed, except the cap and rungs of ladder, which are to be of white oak; all to be built of the sizes and in the manner shown on drawing $\frac{\text{M. R. C.}}{665}$, sheet 5. Each inside corner of leads must be protected with a three (3) inch angle bar, six and one-tenth (6.1) pounds per foot, checked in flush and fastened with five-eighths ($\frac{5}{8}$) inch screw bolts athwartship and five-eighths ($\frac{5}{8}$) inch clinch bolts fore and aft. All heads must be flush and at a distance of eighteen (18) inches apart. The whole must be built in a first-class and substantial manner.

57. *Painting.*—The hull above the water line and the leads will receive three (3) coats of pure white lead and linseed oil toned to lead color.

SPECIAL CONDITIONS.

58. *Inspection.*—An inspector will be appointed by the United States, who will supervise the work. He shall be allowed by the contractor free access to the work and full facilities for inspection at all times, and no article of material or workmanship shall be used without his knowledge and approval. In case of any disagreement as to the meaning of these specifications, the decision of the engineer officer in charge shall be final, and he shall have the right to require the immediate removal of any employee of the contractor deemed incompetent or otherwise objectionable.

59. *Delivery.*—All of the pile sinkers, as above specified, must be completed and delivered at Cairo, Illinois, to the authorized agent of the engineer officer in charge, within three (3) months after date of notification of award of contract.

60. *Changes.*—The right is reserved to make any changes in the details of the construction which the engineer officer in charge may consider necessary, at any time during the progress of the work.

61. *Omissions.*—In general, the object of these specifications is to secure for the United States first-class pile sinkers, constructed of the best material and in the best manner. Should there be any omission in the specifications, either in the text or the drawing, the contractor must supply such omission in accordance with the best practice of boat builders, without extra charge.

(DRAWINGS $\frac{\text{M. R. C.}}{665}$, SHEET 5.)

H. E. WATERMAN,
Captain, Corps of Engineers,
Secretary Mississippi River Commission.

MISSISSIPPI RIVER COMMISSION, OFFICE OF THE SECRETARY,
St. Louis, Mo., March 14, 1898.

IMPROVING MISSISSIPPI RIVER—ADVERTISEMENT, INSTRUCTIONS, SPECIFICATIONS, PROPOSAL, ETC., FOR SMALL STEAM TENDERS, FOR MISSISSIPPI RIVER COMMISSION.

ADVERTISEMENT.

PROPOSALS FOR STEAM TENDERS AND PILE SINKERS.—Mississippi River Commission, 2732 Pine street, St. Louis, Mo., March 14, 1898.—Sealed proposals, in triplicate, for furnishing three small steam tenders and four pile sinkers, will be received here until 12 o'clock noon, standard time, April 14, 1898, and then publicly opened. Information furnished on application. H. E. WATERMAN, Capt. Eng'rs, Sec'y.

SPECIFICATIONS.

GENERAL INSTRUCTIONS FOR BIDDERS.

1. The attention of bidders is especially invited to the acts of Congress approved February 26, 1885, and February 23, 1887, as printed in vol. 23, page 332, and vol. 24, page 414, United States Statutes at Large, which prohibit the importation of foreigners and aliens, under contract or agreement, to perform labor in the United States or Territories or the District of Columbia.

2. Preference will be given to articles or materials of domestic production, conditions of quality and price being equal, including in the price of foreign articles the duty thereon.

3. Bidders, or their authorized agents, are expected to visit the localities referred to and to make their own estimates of the facilities and difficulties attending the execution of the work, including the uncertainty of weather and all other contingencies.

4. No proposal will be considered unless accompanied by a guaranty in manner and form as directed in these instructions.

5. All bids and guaranties must be made in triplicate upon printed forms to be obtained at this office.

6. The guaranty attached to each copy of the bid must be signed by two responsible guarantors, to be certified as good and sufficient guarantors by a judge or clerk of a United States court, a United States district attorney, a United States commissioner, or a judge or clerk of a State court of record, with the seal of said court attached.

7. A firm as such will not be accepted as surety, nor a partner for a copartner or firm of which he is a member. Stockholders who are not officers of a corporation may be accepted as sureties for such corporation. Sureties must be citizens of the United States.

8. Each signature to guaranties and bonds shall have affixed to it an adhesive seal. All signatures to proposals, guaranties, contracts, and bonds should be written out in full, and each signature to guaranties, contracts, and bonds should be attested by at least one witness, and, when practicable, by a separate witness to each signature.

9. Each guarantor will justify in the sum of twenty (20) per centum of the amount of the bid. The liability of the guarantors and bidder is determined by the act of March 3, 1883, 22 Statutes, 487, Chap. 120, and is expressed in the guaranty attached to the bid.

10. A proposal by a person who affixes to his signature the word "president," "secretary," "agent," or other designation, without disclosing his principal, is the proposal of the individual. That by a corporation should be signed with the name of the corporation, followed by the signature of the president, secretary, or other person authorized to bind it in the matter, who should file evidence of his authority to do so. That by a firm should be signed with the firm name, either by a member thereof or by its agent, giving the names of all members of the firm.

11. The place of residence of every bidder, and post-office address, with county and State, must be given after his signature.

12. All prices must be written as well as expressed in figures.

13. One copy each of the advertisement, the instructions for bidders, and the specifications, all of which can be obtained at this office on application by mail or in person, must be securely attached to each copy of the proposal and be considered as comprising a part of it.

14. Proposals must be prepared without assistance from any person employed in or belonging to the military service of the United States or employed under this office.

15. No bidder will be informed, directly or indirectly, of the name of any person intending to bid or not to bid or to whom information in respect to proposals may have been given.

16. Anyone signing the proposal as the agent of another or others must file with it legal evidence of his authority to do so.

17. All blank spaces in the proposal and bond must be filled in, and no change shall be made in the phraseology of the proposal, or addition to the items mentioned therein. Any conditions, limitations, or provisos attached to proposals will be liable to render them informal and cause their rejection.

18. Alterations by erasure or interlineation must be explained or noted in the proposal, over the signature of the bidder.

19. If a bidder wishes to withdraw his proposal, he may do so before the time fixed for the opening, without prejudice to himself, by communicating his purpose in writing to the officer who holds it, and when reached it shall be handed to him or his authorized agent unread.

20. Reasonable grounds for supposing that any bidder is interested in more than one bid for the same item will cause the rejection of all bids in which he is interested.

21. No bids received after the time set for opening of proposals will be considered.

22. The proposals and guaranties must be placed in a sealed envelope marked "Proposals for small steam tenders," and inclosed in another sealed envelope addressed to Captain H. E. Waterman, Corps of Engineers, U. S. A., Secretary Mississippi River Commission, 2732 Pine street, St. Louis, Mo.

23. The United States reserves the right to reject any and all bids, and to waive any informality in the bids received; also to disregard the bid of any failing bidder or contractor known as such to the Engineer Department.

24. The bidder to whom award is made will be required to enter into written contract with the United States, with good and approved security, in an amount of twenty (20) per centum of the total amount of the contract, within ten (10) days after being notified of the acceptance of his proposal.

25. The contract which the bidder and guarantors promise to enter into shall be, in its general provisions, in the form adopted and in use by the Engineer Department of the Army, blank forms of which can be inspected at this office, and will be furnished if desired to parties proposing to put in bids. Parties making bids are to be understood as accepting the terms and conditions contained in such form of contract.

26. The sureties are to make and subscribe affidavits of justification on the back of the bond to the contract and they must jointly justify in double the amount of the penalty.

27. Bidders are invited to be present at the opening of the bids.

GENERAL CONDITIONS.

28. A copy of this advertisement, specifications, and instructions will be attached to the contract and form a part of it.

29. The contractor should, within ten (10) days from the award of the contract, furnish this office with the post-office address to which communications should be sent.

30. Transfers of contracts, or of interests in contracts, are prohibited by law.

31. The contractor will not be allowed to take advantage of any error or omission in these specifications, as full instructions will always be given should such error or omission be discovered.

32. The decision of the engineer officer in charge as to quality and quantity and as to the interpretation of these specifications shall be final.

33. Should the time for the completion of the contract be extended, all expenses for inspection and superintendence during the period of the extension, the same to be determined by the engineer officer in charge, shall be deducted from payments due or to become due to the contractor: *Provided, however,* That if the party of the first part shall, in the exercise of his discretion, because of freshets, ice, or other force or violence of the elements, allow the contractor additional time in writing as provided for in the form of contract, there shall be no deduction for the expenses for inspection and superintendence for such additional time so allowed: *Provided further,* That nothing in these specifications shall affect the power of the party of the first part to annul the contract as provided for in the form of contract adopted and in use by the Engineer Department of the Army.

DETAILED SPECIFICATIONS.

34. *General.*—The work to be contracted for under these specifications is the building of three (3) small stern-wheel steamboats, with engines and boilers, cabins and pilot houses, together with such parts and appurtenances as are hereinafter described, and shall comprise all the labor and material of every description necessary for the due completion, testing under steam, and delivery of said boats. The following specifications will describe and refer to one (1) boat only, and it is understood that all the three (3) boats to be contracted for shall be in all respects similar and made in accordance with these specifications and the drawings herein referred to.

35. *Drawings.*—The drawings furnished to contractor will be the following, and will be marked and known by the numbers here indicated: $\frac{\text{M. R. C.}}{681}$

Sheet 1, lines of hull.
Sheet 2, elevation.
Sheet 3, longitudinal section.
Sheet 4, main deck plan.
Sheet 5, cross sections.

36. *Model.*—The contractor will be required to make his own model according to the lines on Sheet No. 1, and also to furnish a neatly finished model to the same scale as the drawing and deliver same to this office at as early a date as possible after the awarding of the contract.

37. *General dimensions*—

Length between perpendiculars	80′ 0″
Length over fantails	93′ 0″
Beam, molded	17′ 0″
Width over nosings	18′ 4″
Depth, molded	3′ 9″
Crown of deck	4″
Sheer, forward	1′ 6″
Sheer, aft	1′ 0″
Draft, fully equipped, estimated at	2′ 0″

HULL.

38. *Material.*—All steel used in the construction of the hull to have a tensile strength of 54,000 to 62,000 pounds per square inch, an elongation of about 25 per cent in 8 inches, with a minimum reduction of area at fracture of 50 per cent, and must be able to double over close upon itself without showing signs of fracture upon its outside edges. No plate or shape to be used if more than 2½ per cent lighter than its standard weight.

39. *Plating.*—Outside plating to be $\frac{3}{16}$ inch thick except knuckle, which is to be ½ inch thick. The longitudinal seams to be single riveted lap and all transverse seams to be double riveted butt, with butt straps on inside $\frac{1}{16}$ inch thicker than the plates which they connect. The abutting edges of plates to be planed or otherwise fitted metal to metal. The outside strakes of plating to have fillers fitted in under every frame, of the full width of the angle.

40. *Riveting.*—The rivets to be ½ inch in diameter for the general work thoughout the hull except where the nature of the work calls for some other size. Rivets to be either soft steel or best iron, and rivet spacing to be in accordance with the rules of the American Shipmasters' Association.

41. *Bulkheads.*—The hull to be divided into four (4) water-tight compartments by transverse water-tight bulkheads, on frames No. 8, No. 27, and No. 42, respectively, and to be stiffened longitudinally by two fore and-aft bulkheads. These latter to be of $\frac{3}{16}$ inch plate with top and bottom chords of 2½″ × 2½″ × 4.5 lb. angle bar, and stiffened by 2″ × 2″ × 3.2 lb. angles spaced 18 inches apart to coincide with frames. The bottom angle to be riveted to each reverse frame and the top angle perforated with holes for securing deck beams. The longitudinal bulkheads are placed at a distance of 8 feet apart and are not to be water-tight. The transverse bulkheads to be of $\frac{3}{16}$ inch plates riveted to floor frames and stiffened by 2″ × 2″ × 3.2 lb. angles, spaced 2 feet apart.

42. *Frames.*—Frames to be 3″ × 2″ × 4.5 lb. angles, in not more than two pieces. Reverse frames to be 2″ × 2″ × 3.2 lb. angles extending from knuckle to knuckle. Frames to be spaced 18 inches apart.

43. *Stringers.*—A plate 18 inches wide and ½ inch thick to run all fore and aft on each side of hull, projecting 6 inches outboard and secured to skin plating of the gunwale bar, which is to be 2½″ × 2½″ × 5 lb. angle. On the inboard side the stringers are to be attached to every frame by $\frac{3}{16}$ inch gusset plates and 2″ × 2″ × 3.2 lb. angle clips. At the bow end these plates are to be made wider outboard to carry the outriggers and head block for towing head, and at the engine room they are to extend inboard far enough to take the cylinder beams and waterway alongside of deck.

44. *Transom.*—To be made of $\frac{3}{16}$ inch plate and have a 3″ × 2″ × 4.5 lb. angle bar riveted to the top edge bent to camber of deck and perforated with holes for bolting deck planking.

45. *Stem.*—To be made of 1½″ × 3″ bar. The floors in bow, No. 1 to No. 5, to be made of $\frac{3}{16}$ inch plate and a foundation plate to be riveted on floors No. 3, No. 4, and No. 5, to receive capstan engine.

46. *Cylinder beams.*—These are to be built up of steel plates ½ inch thick and 2½″ × 2½″ × 5 lb. angles riveted to stringers and strengthened by angle braces or gussets. as shown on sheet No. 4, and by stanchions in the hold.

47. *Boiler bed.*—Four 6" × 8 lb. channel bars to be riveted to floors No. 16 to No. 22, inclusive, spaced as shown on sheet No. 5 with a ¼-inch plate riveted on top and extending to fore-and-aft bulkheads and secured thereto by 2" × 2" × 3.2 lb. angles. Similar provision to be made for supporting back end of boiler.

48. *Rudders.*—Two balanced rudders, each spaced 4 feet 9 inches from center line of boat, to be made with stocks of 4-inch diameter extra heavy wrought iron or steel tube, and blades of ⅜-inch steel plate, of the size and shape required. The rudder tube to be about 7 inches diameter, bushed at each end for bearings for rudder stock and secured to hull by a riveted flange, and otherwise substantially braced by angle bars and gussets. The rudder stocks to have iron bands shrunk on, turned to form journals, and to have solid ends welded in at top which will be squared to receive the wrought iron tillers. Flanges and friction rings of brass to be provided to carry the weight of rudders.

49. *Wheel chains.*—Chains of 1 inch diameter with 1¼-inch turn-buckles to be fitted to cylinder beams, as shown on Sheet No. 3. The braces to be made of 4-inch pipe stepped on cylinder beams and secured thereto, and the heads to be tied by a ⅝-inch bolt with a piece of 1½-inch pipe between.

50. *Deck beams.*—To be of white oak 2" × 4¼" dressed on four sides and bolted to frame gussets, stringer plates, and longitudinal bulkheads.

51. *Deck.*—To be of white pine 1¾" × 5" dressed and outgauged for caulking. The center strake of forward deck to be white oak, of sufficient width to receive the base of capstan. Deck to be fastened with 16d wire spikes and caulked with one thread of cotton and one thread of oakum and seams payed with pitch.

52. *Plank-sheer and nosing.*—To be of white oak. The upper plank-sheer, 1¾" × 10", to be bolted through stringer plate and through lower plank-sheer, which is to be 5" × 6". Nosing to be 2" × 7" spiked to upper and lower plank-sheer. Where oak comes in contact with steel anywhere throughout the boat a thickness of tarred felt must be interposed.

53. *Flooring.*—Floors of 1½-inch white pine to be laid in bunkers and stoke hold and to be made with ship lap joints so they can be taken up to clean and paint the metal work beneath them.

54. *Fenders.*—Two tow fenders at bow to be white oak about 10 inches wide. The side stationary fenders to be white oak 4" × 6" at bottom and 4" × 4" at top, and swinging fenders 4" × 6" at bottom and 2½" × 5" at top, properly lashed in place.

55. *Stack knees, bits and cavils.*—Two stack knees of white oak to be placed at bow and firmly secured by knees of steel plates and angles. The usual bitts and sheave chocks also to be placed at bow, as shown on sheet No. 4, made and secured in a first-class manner. Six iron cavils to be located as shown and bolted through stringer plates and plank-sheers. Two ring bolts to be placed at after end of fantails.

56. *Hatches.*—Hatchways to be cut in deck for coal and for access to the hold. The coal hatches to be fitted with iron frames, gratings, and covers, and the hatches in cabins to have covers flush with deck and ring bolts for lifting. Man-ways to be cut in bulkheads to give access to those compartments not provided with hatchways.

57. *Painting.*—The iron work to be painted with one coat of metallic paint when put in place, to prevent rusting, and when completed, the outside to receive two more coats before launching; each coat to be thoroughly dry before the next is applied.

58. *Testing.*—The hull to be tested for leaks, before being launched, by having the bottom filled with water to a depth of about 6 inches.

CABIN AND BOILER DECKS.

59. *Deckhouse.*—To extend from forward bulkhead to engine room at a width of 12 feet, and from thence to splash bulkhead to be widened out to 17 feet. The boiler room to be 27 feet long and divided from cabin by bulkhead sided on both sides of studding up to roof of skylight. The cabin to be 13 feet 6 inches long and kitchen 7 feet 3 inches long, divided from cabin and engine room by single bulkheads extending to roof of skylight. Main posts to be 3" × 3" and studs 1½" × 3" white pine. The whole to be sided with ⅞ inch white pine. The strakes to be about 3 inches wide, tongued and grooved and beaded on the outside, and laid horizontally, except at the rounded corners at bow, which will be vertical.

60. *Boiler deck.*—To be laid with ⅞ inch white pine in strakes about 3 inches wide, tongued and grooved and beaded on under side, and finished in the usual manner with waterways, facing, and nosing.

61. *Skylight.*—To be 9 feet 6 inches wide, and extend from forward end of boiler room aft to within 3 feet of splash bulkhead; to be 2 feet high and fitted with transom sashes as shown on sheets No. 2 and No. 3. The carlines to be of white pine 1½" × 4", spaced about 18 inches apart, and the roof laid with ⅞-inch white pine same as on boiler deck and finished in the same manner.

62. *Roof.*—All roofs to be covered with a first-class quality of 10-oz. cotton duck, fastened with 10-oz. tinned tacks, and painted two coats of pure white lead and yellow ochre ground in linseed oil and properly sanded.

63. *Doors and windows.*—The boiler room to have a window at bow end and two shutters at each side, arranged as shown on sheets No. 2 and No. 4, and the engine room to have two windows on each side and the usual shutters, in two folds, for giving access to engines. The cabin and kitchen are each to have two doors 1⅛ inch thick, lower part paneled and upper part glass. The end doors to engine room to be of similar construction. The boiler room to have sliding, battened doors 4 feet wide, and the doors to closets and crew's bunks in engine room also to be battened doors. All the battened doors to be made from ⅞-inch white pine siding. The glass used for doors and windows on main deck to be double strength American, and all the other glass to be single strength. All doors to have locks of good quality, with black, porcelain knobs, and all windows, doors, and transom sashes to be fully fitted with necessary hinges, hooks, and fastenings of good quality.

64. *Ladders.*—One iron ladder at forward end of cabin from main to boiler deck, two short ladders from boiler deck to skylight roof, and two ladders in stoke hold to be provided and fitted in place.

65. *Pilot house.*—To be 10 feet wide and 8 feet long, built at the forward end of and in line with front of deck house, and to be fitted with sliding sash on three sides and with adjustable sight shades at front in the usual manner. The pilot house to be fitted up with folding seat, 30 inches wide when opened out, to answer for a bunk, and also with the necessary speaking tubes, bell trumpets, and bell and whistle cords.

66. *Steering wheel, etc.*—Steering wheel to be 6 feet diameter and fitted up in pilot house in first-class manner, and have all tiller ropes, guide sheeves, etc., necessary for the proper working of the rudders.

67. *Bell, etc.*—One 8 inch gong and 1 jingler to be placed in engine room, with bell trumpet and wire bell pulls leading to pilot house, fitted up in first-class manner.

68. *Flag poles.*—One flag pole to be fixed at the after end of pilot house and one at splash bulkhead.

69. *Crew's quarters and closets.*—Two closets to be built at after end of engine room. The soil pipes to be steel tubes of suitable size and shape, flanged at bottom end and riveted to plating of hull. Forward of closets a room to be built, sided about 6 feet high and fitted with four bunks 30 inches wide. The main posts for this room to go up to roof of skylight. The tillers swing over the top of this room, and consequently they must be framed with this in view. Forward of crew's room a locker is to be placed, but should this not leave sufficient space for operating levers the contractor may place locker in some other place to be hereafter selected.

70. *Down spouts and scuppers.*—Two down spouts from pilot house 1 inch diameter, three on each side of skylight 1¼ inch diameter and three swinging scuppers on each side of boiler deck 2 inches diameter, of heavy tin or galvanized iron, to be furnished and fitted in place.

71. *Furnishing.*—The cabin to be fitted with two double bunks placed as shown on plan sheet No. 4, each having a drop seat attached to the lower rail; one table 2′ 6″×5′ 0″ with white pine frame and hardwood top; one white enameled iron corner washbowl with nickel-plated cocks, fitted in place, with waste pipe of iron connected to side of hull without trap, one of the basin cocks to be connected to the under side of shell of heater. The kitchen to be furnished with a table 2′ 0″×3′ 6″ with white pine frame and hardwood top; one white enameled iron sink 24″×14″ secured in place and fitted with iron waste pipe connected to side of hull and without trap. A table to be fitted to side of kitchen with drain board to sink, and above table three tiers of shelves 10 inches wide and 6 feet long. On starboard side a cupboard with double doors top and bottom, and shelves complete. On port side a cooking range to be placed and fitted complete with the necessary smoke pipe carried to center of skylight and provided with galvanized iron casing, deck flange and hood properly secured and made water-tight. All woodwork to be amply protected against fire by linings of sheet zinc and air spaces. The range to be No. 204 Majestic, plain shelf, or other of equal size and quality.

72. *Work bench.*—A vise bench to be provided in engine room, placed as shown on sheet No. 4.

73. *Painting.*—All woodwork above main deck to receive three coats of pure white lead and raw linseed oil; all knots to receive a coat of shellac. Three name boards with name of boat in gilt letters on a dead black ground to be put on sides of pilot house and the name to be also painted on splash bulkhead and on each side of bows, as shall be directed. The draft marks also to be painted on bow and quarters.

MACHINERY.

74. *Engines.*—One pair of stern wheel engines with cylinders 8¼ inches in diameter and 48 inches stroke fitted with poppet valves and California cut-off or other of

equal merit, and designed of sufficient strength for working under a steam pressure of 180 pounds per square inch, to be furnished and fitted in place complete.

75. *Shaft and wheel.*—Shaft to be of hammered steel 4½ inches hexagon and about 15 feet long, fitted with three cast-iron wheel flanges, having pockets for 12 paddle arms. Wheel to be 12 feet outside diameter of buckets and buckets to be 13 feet long and 18 inches wide. Arms and buckets to be of white oak and wheel to be fitted with circles made of 3/16"×2½" iron on each side of each set of arms, bolted with three ½-inch bolts to each segment.

76. *Cranks.*—To be of forged steel, shrunk and keyed on shafts and fitted with steel wrist pins.

77. *Pitmans.*—To be built up of iron or steel tubing with solid stub ends and braced efficiently with truss rods.

78. *Slides, etc.*—Slides and cross-head to be of cast iron carefully finished and fitted with bronze gibs.

79. *Operating gear.*—Throttle valve to be overhead, with reversing and cut-off shafts below deck, and provided with necessary handles and quadrants as shown on sheets No. 4 and No. 5. Ship-up rig and all other fittings required for the proper working of the engines to be provided.

80. *Steam and exhaust pipes.*—To be of lap welded steel tubing, with flange couplings, fitted in accordance with the requirements of the rules of the Steamboat-Inspection Service. The main steam line to be 3 inches in diameter, and the branches to cylinders 2 inches in diameter; exhaust to be 3 inches diameter and provided with blast pipe to chimney and escape to atmosphere with valve for regulating same.

81. *Heater.*—To be placed athwartship near boiler bulkhead and fitted with a coil of 1-inch iron pipe and all connections from feed pump to boiler.

82. *Pumps and syphons.*—The following will be furnished: One outside packed plunger pump for feeding boiler, furnished with a separate valve, and hose coupling for fire purposes and washing down; one hand deck pump, connected to mud drum for filling boiler and hose connection for washing out boiler; four bilge syphons, with all connecting pipes and valves, placed most conveniently, one in each water-tight compartment. A pump well 12 inches in diameter to be placed in corner of stoke hold, and to be connected to both sides of boat; the intake pipes to be fitted to screen boxes riveted to hull, and provided with straightway valves placed as near to hull as practicable.

83. *Capstan.*—One single barrel steam capstan, "Providence" or other of equal quality, to be placed on forward deck with engines in hold. Cylinders to be 4 inches diameter and 6 inches stroke, and fitted with starting valve and all oil cups, etc.

84. *Boiler and fittings.*—The boiler to be 44 inches diameter and 16 feet long, with 18 tubes, each 4 inches diameter, and to be built of marine steel of 60,000 to 65,000 pounds tensile strength and .33 inches thick, for a working pressure of 180 pounds per square inch. All holes to be drilled, with the horizontal seams double riveted and arranged so as to be above the fire line. Steam and mud drums as shown on drawings to be provided, and all flat surfaces to be efficiently stayed where required. The boiler to be provided with the usual casing made of No. 16 sheet steel, stiffened with angle bars, and to have a cast-iron front, and all doors, grate bars, and bearers necessary. The smokestack is to be of No. 14 and No. 16 sheet steel with breeching of No. 14 sheet steel, and with casings and umbrella for roof. The ash pan is to be of No. 12 sheet steel lined with split brick. The boiler is to be built in with best fire brick in a good and substantial manner. The boiler is to be furnished with a spring safety valve, a 3-inch extra heavy steam valve, a blow-off valve, feed and check valves, a water gauge and three try cocks, two steam gauges, one long bell whistle 4 inches diameter with valve for same worked from pilot house. Steam valves for feed pump, bilge syphons and whistle to be connected directly to steam drum. All piping and valves, together with sight feed lubricator and all drains and oil cups, requisite for the full equipment and operation of the machinery, whether specifically mentioned or not, must be furnished.

85. *Pipe and boiler covering.*—The steam drum, top of boiler, steam pipes from boiler to engine, and exhaust pipes from branches at engine to heater, to be covered with a good magnesia covering, to be approved by the engineer officer in charge.

86. *Tools, etc.*—The following tools, etc., must be furnished: One parallel vise, Prentiss or other of equal quality, with 4½-inch jaws; one 6-inch, one 10-inch, and one 15-inch shifting wrench; such forged and special wrenches as may be requisite about engines; one machinists' hand hammer; six machinists' chisels, assorted; a full set of oilers; one coil of hawser-laid best manila rope, 3½ inches circumference.

SPECIAL CONDITIONS.

87. *Inspection.*—Inspectors will be appointed by the United States to supervise the work, and the contractor must at all times give them access to the work and full facilities for examination of all material and workmanship. Such tests of material as are deemed necessary are to be made at the expense of the contractor, under the supervision of the inspectors.

88. *Extra work.*—It is the intent of these specifications to secure to the United States three (3) steam tenders of first-class construction and best materials, complete in all respects for boats of their class and ready for operation, and everything necessary for this purpose is to be supplied by the contractor, whether specially mentioned in these specifications or not. No claim whatever shall at any time be made upon the United States by the contractor for or on account of any extra work or material performed or furnished, or alleged to have been performed or furnished, unless such extra work or materials shall have been expressly required in writing by the engineer officer in charge, the prices and quantities thereof having been first agreed upon by the contracting parties and approved by the Chief of Engineers.

89. *Time of completion and place of delivery.*—The three boats are to be finished complete, and, after a trial trip of each boat under its own steam of not less than six hours, delivered to the authorized agents of the engineer officer in charge at Cairo, Illinois, within 4½ months from date of notification of award of contract.

90. *Penalty.*—In case of failure to complete and deliver any boat within the time specified, the contractor will be liable for any and all expenses to which the United States may be put because of said failure, the same to be determined by the engineer officer in charge.

91. *Interpretation of contract.*—In case of any doubt or disagreement arising under these specifications, the decision of the engineer officer in charge shall be final, and he shall have the right to require the immediate removal of any employee of the contractor who is deemed incompetent or otherwise objectionable.

92. *Payments.*—When the hull of any boat is finished, its cylinder beams in place, and said boat successfully launched, fifty (50) per cent of the contract price for this boat will be paid. When any boat is completed and received by the engineer officer in charge, forty-five (45) per cent of the contract price for such boat will be paid. Five (5) per cent of the contract price for each boat will be retained for one month after its delivery, to make good any defects that may be discovered in its material or workmanship. The contractor will be required to make good, at his own expense, any defects that may be discovered at any time during the continuance of the contract, even though not discovered by the inspector at an earlier date.

93. *Ownership.*—All parts paid for under the system of partial payments above specified shall become thereby the sole property of the United States, but this provision shall not be interpreted as relieving the contractor from the sole responsibility for the proper care and protection of said parts paid for prior to acceptance, or from any other of the provisions of these specifications.

94. *Proposals.*—Proposals will be received for one, two, or three small tenders, in accordance with the above specifications, and the right is reserved to accept or reject any or all of the bids thus received, or to award the contract in such manner as may be deemed best for the interest of the United States.

(DRAWINGS $\frac{\text{M. R. C.}}{681}$, SHEETS 1, 2, 3, 4, 5.)

H. E. WATERMAN,
Captain, Corps of Engineers,
Sec'y Mississippi River Commission.

MISSISSIPPI RIVER COMMISSION, OFFICE OF THE SECRETARY,
St. Louis, Mo., March 14, 1898.

IMPROVING MISSISSIPPI RIVER—ADVERTISEMENT, INSTRUCTIONS, SPECIFICATIONS, PROPOSAL, ETC., FOR LARGE STEAM TENDERS FOR MISSISSIPPI RIVER COMMISSION.

ADVERTISEMENT.

PROPOSALS FOR STEEL-HULLED STEAM TENDERS.—Mississippi River Commission, 2732 Pine st., St. Louis, Mo., April 27, 1898.—Sealed proposals in triplicate for furnishing five large steel-hulled steam tenders, complete with machinery and cabins, will be received here until 12 o'clock noon, standard time, May 27, 1898, and then publicly opened. Information furnished on application. H. E. WATERMAN, Capt. Eng'rs., Sec'y.

SPECIFICATIONS.

GENERAL INSTRUCTIONS FOR BIDDERS.

1. The attention of bidders is especially invited to the acts of Congress approved February 26, 1885, and February 23, 1887, as printed in vol. 23, page 332, and vol. 24, page 414, United States Statutes at Large, which prohibit the importation of foreigners and aliens under contract or agreement to perform labor in the United States or Territories or the District of Columbia.

2. Preference will be given to articles or materials of domestic production, conditions of quality and price being equal, including in the price of foreign articles the duty thereon.

3. Bidders or their authorized agents are expected to visit the localities referred to and to make their own estimates of the facilities and difficulties attending the execution of the work, including the uncertainty of weather and all other contingencies.

4. No proposal will be considered unless accompanied by a guaranty in manner and form as directed in these instructions.

5. All bids and guaranties must be made in triplicate upon printed forms to be obtained at this office.

6. The guaranty attached to each copy of the bid must be signed by two responsible guarantors, to be certified as good and sufficient guarantors by a judge or clerk of a United States court, a United States district attorney, a United States commissioner, or a judge or clerk of a State court of record, with the seal of said court attached.

7. A firm as such will not be accepted as surety, nor a partner for a copartner or firm of which he is a member. Stockholders who are not officers of a corporation may be accepted as sureties for such corporation. Sureties must be citizens of the United States.

8. Each signature to guaranties and bonds shall have affixed to it an adhesive seal. All signatures to proposals, guaranties, contracts, and bonds should be written out in full, and each signature to guaranties, contracts, and bonds should be attested by at least one witness, and when practicable, by a separate witness to each signature.

9. Each guarantor will justify in the sum of twenty (20) per centum of the total amount of the bid. The liability of the guarantors and bidder is determined by the act of March 3, 1883, 22 Statutes, 487, chapter 120, and is expressed in the guaranty attached to the bid.

10. A proposal by a person who affixes to his signature the word "president," "secretary," "agent," or other designation, without disclosing his principal, is the proposal of the individual. That by a corporation should be signed with the name of the corporation, followed by the signature of the president, secretary, or other person authorized to bind it in the matter, who should file evidence of his authority to do so. That by a firm should be signed with the firm name, either by a member thereof or by its agent, giving the names of all members of the firm.

11. The place of residence of every bidder and post-office address, with county and State, must be given after his signature.

12. All prices must be written, as well as expressed in figures.

13. One copy each of the advertisement, the instructions for bidders, and the specifications, all of which can be obtained at this office on application by mail or in person, must be securely attached to each copy of the proposal and be considered as comprising a part of it.

14. Proposals must be prepared without assistance from any person employed in or belonging to the military service of the United States or employed under this office.

15. No bidder will be informed, directly or indirectly, of the name of any person intending to bid or not to bid or to whom information in respect to proposals may have been given.

16. Anyone signing the proposal as the agent of another or others must file with it legal evidence of his authority to do so.

17. All blank spaces in the proposal and bond must be filled in, and no change shall be made in the phraseology of the proposal, or addition to the items mentioned therein. Any conditions, limitations, or provisos attached to proposals will be liable to render them informal, and cause their rejection.

18. Alterations by erasure or interlineation must be explained or noted in the proposal over the signature of the bidder.

19. If a bidder wishes to withdraw his proposal he may do so before the time fixed for the opening, without prejudice to himself, by communicating his purpose in writing to the officer who holds it, and, when reached, it shall be handed to him or his authorized agent, unread.

20. Reasonable grounds for supposing that any bidder is interested in more than one bid for the same item will cause the rejection of all bids in which he is interested.

21. No bids received after the time set for opening of proposals will be considered.

22. The proposals and guaranties must be placed in a sealed envelope marked "Proposals for Large Steam Tenders," and inclosed in another sealed envelope addressed to Captain H. E. Waterman, Corps of Engineers, U. S. A., Secretary Mississippi River Commission, 2732 Pine street, St. Louis, Mo.

23. The United States reserves the right to reject any and all bids, and to waive any informality in the bids received; also to disregard the bid of any failing bidder or contractor known as such to the Engineer Department.

24. The bidder to whom award is made will be required to enter into written contract with the United States, with good and approved security, in an amount of twenty (20) per centum of the total amount of the contract, within ten (10) days after being notified of the acceptance of his proposal.

25. The contract which the bidder and guarantors promise to enter into shall be, in its general provisions, in the form adopted and in use by the Engineer Department of the Army, blank forms of which can be inspected at this office, and will be furnished if desired to parties proposing to put in bids. Parties making bids are to be understood as accepting the terms and conditions contained in such form of contract.

26. The sureties are to make and subscribe affidavits of justification on the back of the bond to the contract, and they must jointly justify in double the amount of the penalty.

27. Bidders are invited to be present at the opening of the bids.

GENERAL CONDITIONS.

28. A copy of this advertisement, specifications, and instructions will be attached to the contract and form a part of it.

29. The contractor should, within ten (10) days from the award of the contract, furnish this office with the post-office address to which communications should be sent.

30. Transfers of contracts, or of interests in contracts, are prohibited by law.

31. The contractor will not be allowed to take advantage of any error or omission in these specifications, as full instructions will always be given should such error or omission be discovered.

32. The decision of the engineer officer in charge as to quality and quantity and as to the interpretation of these specifications shall be final.

33. Should the time for the completion of the contract be extended, all expenses for inspection, and superintendence during the period of the extension, the same to be determined by the engineer officer in charge, shall be deducted from payments due or to become due to the contractor: *Provided, however,* That if the party of the first part shall, in the exercise of his discretion, because of freshets, ice, or other force or violence of the elements, allow the contractor additional time in writing as provided for in the form of contract, there shall be no deduction for the expenses for inspection and superintendence for such additional time so allowed: *Provided, further,* That nothing in these specifications shall affect the power of the party of the first part to annul the contract as provided for in the form of contract adopted and in use by the Engineer Department of the Army.

SPECIAL CONDITIONS.

34. *General.*—The work to be contracted for under these specifications is the building of the hulls, cabins, and machinery of five (5) stern-wheel tenders or towboats, together with such parts and appurtenances as are hereinafter described, and shall comprise all of the materials, tools, labor, etc., of every description requisite and necessary for the proper and entire completion and delivery of the same. During the course of their construction the tenders will be known as No. 1, No. 2, No. 3, No. 4, and No. 5, respectively, and will be referred to in these specifications by those numbers. The following specifications will describe and refer to one boat only, but it must be understood that tenders Nos. 1, 2, 3, and 4 shall be in all respects alike and built in accordance with these specifications and the drawings herein referred to. Tender No. 5 will be similar to Nos. 1, 2, 3, and 4, excepting that the main engines and the wheel are to be larger, and such other minor modifications are to be made to correspond therewith as hereinafter specified.

35. *Proposals.*—Proposals will be received for any one or more of the tenders, and bidders must state the number that they propose to furnish and the price for each with high-pressure engines and exclusive of refrigerating plant. Bidders must also state a separate additional price for each refrigerating plant called for by the specifications, and a separate additional price for each of the compound engines if furnished instead of the high-pressure engines. The right is reserved to accept or reject any or all bids or parts thereof, and to make such awards as may be deemed most advantageous to the United States.

36. *Bidders' and contractors' drawings.*—Bidders must submit with their proposals drawings, in triplicate, showing the types of the main engines (high pressure and compound) and general plan of the refrigerating plant that they propose to furnish, as required in paragraphs 124, 125, 167, and 168; and also specifications, in triplicate, giving full description of the same. A copy of these specifications should be attached to each copy of the proposal and be referred to therein; the drawings need not be

attached to the proposals, but should be referred to therein. The successful bidder will be required to furnish seven (7) copies of these drawings and specifications to complete the contract. The contractor must also submit to the engineer officer in charge, for approval, any and all working drawings that may be required in the prosecution of the work that are not furnished by the United States, including a complete set of the details of each size of main engine. A complete set of the tracings of these working drawings must also be furnished and delivered at the office of the secretary, Mississippi River Commission, St. Louis, Mo., upon completion of the work and prior to final payment.

37. *Quality of material.*—Except it be otherwise specified, all materials are to be of the best quality of their respective kinds, and all labor is to be done in a most thorough, prompt, and workmanlike manner, to the full satisfaction of the engineer officer in charge. In all cases where an article is mentioned, preceded or followed by the words "or equal," "best quality," "approved quality, make," "or other equally good," or words of like effect, the engineer officer in charge will decide as to the best and most suitable article to be used.

38. *Inspection.*—Inspectors will be appointed by the United States to supervise the work, and the contractor must at all times give them access to the work and full facilities for examination of all material and workmanship. Such tests of material as are deemed necessary are to be made at the expense of the contractor under the supervision of the inspectors. The engineer officer in charge shall have the right to require the immediate removal of any employce of the contractor who is deemed incompetent or otherwise objectionable.

39. *Extra work.*—It is the intent of these specifications to secure to the United States five (5) steam tenders of first-class construction and best materials, complete in all respects for boats of their class and ready for operation. No claim whatever shall at any time be made upon the United States by the contractor for or on account of any extra work or material performed or furnished, or alleged to have been performed or furnished, unless such extra work or materials shall have been expressly required in writing by the engineer officer in charge, the prices and quantities thereof having been first agreed upon by the contracting parties and approved by the Chief of Engineers.

40. *Time and place of delivery.*—Bidders must state in their proposals the time within which they will complete and deliver each one of the tenders they propose to furnish. No proposal that includes a bid for tender No. 5 will be considered that does not contemplate a preference in time of completion and delivery for that tender, and no proposal will be considered that does not contemplate the completion and delivery of all of the tenders on or before July 1, 1899. All tenders must be delivered complete, under their own steam, after a trial trip of not less than six (6) hours, to the engineer officer in charge, or his authorized agent, at Cairo, Illinois.

41. *Penalty.*—In case of failure to complete and deliver any tender within the time specified, the contractor will be liable for and must pay any and all expenses, including the hire or charter of steam tenders or towboats, incurred by the United States because of said failure, said expenses to be determined by the engineer officer in charge.

42. *Payments.*—When the hull of any tender is finished, its cylinder beams in place, and said tender successfully launched, forty (40) per centum of the contract price of that tender will be paid. After the launching of any tender and payment of the forty (40) per centum, monthly payments will be made on that tender on estimates of the engineer officer in charge, or his authorized agent, of the value of the work completed and in place. Five (5) per centum of the contract price for each tender will be retained for one (1) month after its completion and delivery to make good any defects that may be discovered in its material or workmanship. The contractor will be required to make good, at his own expense, any defects that may be discovered at any time during the continuance of the contract, even though not discovered by the inspector at an earlier date.

43. *Ownership.*—All parts paid for under the system of partial payments above specified shall become thereby the sole property of the United States, but this provision shall not be interpreted as relieving the contractor from the sole responsibility for the proper care and protection of said parts paid for prior to final acceptance, or from any other of the provisions of these specifications.

DETAILED SPECIFICATIONS.

44. *Description.*—These boats are to be of the stern-wheel type, with hulls built entirely of steel, wall-sided and without guards, and the towing heads made of sufficient strength to dispense with the usual gallows frame. The flat bottom will have a dead rise of 1 inch from the outboard longitudinal truss frame, and the knuckle will be rounded to 15 inches radius.

45. *Drawings.*—The drawings furnished by the United States are those prepared in the office of the Secretary, Mississippi River Commission, and are indexed and catalogued as $\frac{\text{M. R. C.}}{680}$. The numbers and titles of the sheets are as follows:

Sheet 1, lines of hull.
Sheet 2, longitudinal section.
Sheet 3, cross sections.
Sheet 4, details of construction.
Sheet 5, details of construction.
Sheet 6, main-deck plan.
Sheet 7, boiler-deck plan.
Sheet 8, cylinder beams and rudders.

46. *Model of hull.*—The contractor will be required to make his own model according to the lines furnished, and submit the same for approval of the engineer officer in charge before beginning the work. He must also make a finished model to same scale as the drawing of lines, for the use of this office, and deliver same at as early a date as possible after contract is awarded.

HULL.

47. *General dimensions*—

Length between perpendiculars	171′	6″
Length of fantails	195′	6″
Length from forward nosing over the wheel buckets	199′	4″
Beam, molded	36′	0″
Width over nosings	37′	8″
Depth, molded	5′	6″
Crown of deck		6″
Sheer, forward	3′	6″
Sheer, aft	2′	6″
Length of fore body	66′	0″
Length of after body	45′	6″

48. *Framing.*—The boat is to be framed on the transverse system, with six (6) transverse bulkheads, one longitudinal bulkhead in center and four (4) longitudinal truss frames. The frames are numbered from the bow, the bearding line of the stem being zero and the transom frame being No. 114. They will be referred to in these specifications by those numbers. The frames will be spaced at a uniform distance apart of 18 inches, except No. 114, which will be 24 inches. The frames are to be of 3 in. × 2½ in. × 6.6 lb. angle bar, in one piece from center bulkhead to gunwale, and will be connected to bulkhead by gussets of 7.65 lb. plate, which last will stand 15 inches high by 14 inches wide, and will be attached to bulkhead by the stiffening bars on one side and by pieces of 2 in. × 2 in. × 3.2 lb. angle bar on the other. Reverse frames of 2½ in. × 2½ in. × 5 lb. angle bar will be riveted to floor frames and will run up on side frames as marked on body lines shown on sheet 1. The floor frames forward of No. 15 will be strengthened by 7.65 lb. plates 18 inches deep at center as far as frame No. 6, and thence to the bow the plates will be of varying depth as required, as shown on sheets 2 and 4. The reverse frames will be riveted to top edge of plate and run up on sides of frame, as before described. The frames forward of No. 32 will be shaped at top ends and extended to meet the nosing plate, and each frame will be attached to the nosing plate by a clip of 2½ in. × 2½ in. × 5 lb. angle. Reverse frames will not be required at those frames to which transverse bulkheads are riveted.

49. *Stem.*—The stem is to be made from a bar of 5 in. × 1½ in. iron, bent to the shape required. The lower end will be flattened and enlarged at the forefoot to work into the plating to which it will be riveted, and the upper end will be reduced to 3 inches in width to make room for the splice angle of the towing head.

50. *Towing head.*—This will be built of 12.75 lb. plates, flanged and riveted to each side of the stem bar, and shaped to meet the nosing plates at the gunwales, and strengthened on the top edge by a 3 in. × 3 in. × 7.2 lb. angle bar, which last will be bent around the corners of the bow and carried aft to join the gunwale angle. A splice bar of similar-sized angle and 4 ft. long will pass behind stem bar and connect the above. Another angle bar 2½ in. × 2½ in. × 5 lb. will be riveted parallel to and at a distance of 8 inches from the top bar, to receive the nosing; all as shown on sheet 5.

51. *Bow stringers.*—Two (2) stringers of 3 in. × 8.4 lb. Z bar will be riveted to reverse frames in bow, extending from frame No. 1 to collision bulkhead on frame No. 6. These stringers will be placed as near the water line as the conformation of the bow will admit.

52. *Transom.*—The transom built on end frame No. 114 is to be of 10.2 lb. plate 30 inches deep at the center line and connected to bottom and deck plating by 4 in. × 4 in. × 9.8 lb. angle bars.

53. *Deck beams.*—These will be of 3 in. × 8.4 lb. Z bars, spaced to coincide with frames, to which they are to be connected by gussets of 7.65 lb. plate, as shown on sheet 4. The deck beams forward of dead flats will extend to the nosing plates, to which they will be attached by the same clip that secures the frame. The deck beams and frames will be connected together by bracing made of plates and angles, as shown on sheet 5. At the transom, a 4 in. × 4 in. × 9.8 lb. angle bar will be substituted for the Z bar.

54. *Transverse bulkheads.*—There will be six (6) transverse bulkheads, placed respectively on frames No. 6, No. 22, No. 41, No. 61, No. 81, and No. 98. They are all to be water tight, and made of 7.65 lb. plate, riveted to floor and deck beams and stiffened by 2 in. × 2 in. × 3.2 lb. angle bars, placed alternately on opposite sides of bulkheads at a distance of 24 inches apart. The joints of plates are to be double-riveted lap. A manhole will be cut in collision bulkhead, strengthened by an iron ring and provided with water-tight door.

55. *Longitudinal bulkhead.* -This bulkhead will be on the center line of boat, and will extend for the full height of hold, from frame No. 21 at the bow to the transom at the stern. Forward of frame No. 21 it will be continued, of diminishing height, until it meets floor No. 14, to which it will be secured by 2 in. × 2 in. × 3.2 lb. angle clips. The top edge of this part of bulkhead will be stiffened by a 2½ in. × 2½ in. × 5 lb. angle bar. The bulkhead will be connected to bottom plating by two (2) 2½ in. × 2½ in. × 5 lb. angle bars, which will be intercepted by each transverse bulkhead, leaving limber holes in each corner, as shown on sheet 4. The top of bulkhead will be strengthened by two (2) 2½ in. × 2½ in. × 5 lb. angle bars running continuously from frame No. 6 to transom, and passing through the transverse bulkhead. Each deck beam will be secured to these angle bars by two (2) ⅝ in. rivets, and in addition by a clip of 2½ in. × 2½ in. × 5 lb. angle bar, as shown on sheet 4. The connection of longitudinal and transverse bulkheads at their intersections will be made by four (4) 2½ in. × 2½ in. × 5 lb. angle bars. The bulkhead is to be made of 7.65 lb. plate, stiffened with 2 in. × 2 in. × 3.2 lb. angle bars placed alternately on opposite sides at a distance of 18 inches apart, coinciding with the floor frames to which they are attached by gussets, as described in paragraph 48. The joints of plates will be double-riveted lap. This bulkhead will not be water-tight, and manways 12 inches × 16 inches will be made in position shown on sheet 2, which are to be stiffened on the free edges with 1½ in. × ½ in. bar, but will not require doors. Limber holes will be made at corners of intersections with transverse bulkheads.

56. *Truss framing.*—Four (4) longitudinal truss frames will be run all fore and aft of hull, spaced at a distance of 6 feet, center to center on each side of longitudinal bulkhead. The top and bottom chords are each to be made of two (2) 2½ in. × 2½ in. × 5 lb. angles and a 10.2 lb. web plate 10 inches wide. These chords will be riveted to reverse frames and deck beams, and will be further secured to each by clips of 2½ in. × 2½ in. × 5 lb. angles. The chords will pass through the transverse bulkheads intact and be made water-tight by the angle connections. Lattice bracing in double panels, made of 2½ in. × 2½ in. × 4.1 lb. angles, will be worked in between transverse bulkheads, all as shown on sheet 4. The after ends of truss frames will be attached to transom by double angles 2½ in. × 2½ in. × 5 lb.

57. *Gunwales.*—A gunwale angle, 3 in. × 3 in. × 7.2 lb., will be placed outside of hull and be riveted to both sheer strake and plate sheer. It will extend continuously from the end of fantail around front of towing head to stem.

58. *Stanchions.*—Such stanchions as may be needed in fire hold, under boilers and under any part of the machinery not sufficiently carried by bulkheads and truss frames, will be supplied and riveted to floor and deck beams in an efficient manner.

59. *Hull plating.*—The forward part of boat to about frame No. 30 will be plated with 12.75 lb. plate; the bilge strake or knuckle and the center or keel strake are to be of 12.75 lb. plate throughout, and the remainder will be plated with 10.2 lb. plate, except on the under side of guard, forward of about frame No. 24, where plating is to be 7.65 lb. The seams of keel strake will be double riveted and all other seams single riveted, and all butts will be double riveted. The plating will be in 15 strakes laid alternately inside and outside, the keel strake being an inside strake. The width of bottom strakes on dead flat will be 36 inches center to center of laps, and the ruling length of plates will be 18 feet. All butts will be planed or otherwise fitted close, metal to metal. Butt straps will be 1/16 inch thicker than the plates which they connect and will be fitted close between the edges of inside strakes. Solid liners in one length will be fitted at every frame between frame and outside strakes of plating. The liners will be the full width of the flange of frame to which they are fitted, except in the way of water-tight bulkheads, where they will extend in one piece from the fore edge of the frame before to the after edge of the frame abaft the bulkhead. The points of intersection of bulkheads where the angles of longitudinal bulkhead are intercepted by the limber holes will be strengthened by 12.75 lb. plates 18 inches wide, extending about 2 feet fore and aft and riveted on the outside of skin plating.

60. *Deck plating.*—This will be in thirteen (13) strakes, each 36 inches wide, center to center of laps, except the plate sheer, which must be of the requisite width to come flush with gunwale angle. The center strake and plate sheer are to be of 12.75 lb. plate, and all the remainder are to be of 10.2 lb. plate. The seams, butts, straps, and liners will be similar to those specified for hull plating; but the center strake will be an outside strake, and the plate sheer from frame No. 13 to frame No. 84 will be checkered plate.

61. *Riveting, etc.*—Rivets are to be of soft steel, or Burden's best, and ¾ inch in diameter throughout the hull, except where otherwise specified or noted on drawings or the nature of the work requires a different size. The rivets in seams and butts of outside plating will be spaced not more than 2¼ inches apart center to center, and rivets in seams of all internal water-tight work will be spaced not more than 2¾ in. centers. All double riveting will be chain fashion, except where otherwise noted on drawings. The distance from center to center between the rows will be 1⅝ inches. No rivet will be nearer the seam, butt, or edge of plate or angle bar than its diameter. Spacing of rivets in beam knees will be from 2¾ to 3½ inches centers, but no beam knee will be secured to its frame with less than four (4) rivets. Rivets for securing outside plating to floors and frames, stiffening angle bars to bulkheads, and all work where angle bars do not require to be calked, will be spaced not more than 5 inches centers. Heavy drifting must not be resorted to, and holes not punched fair must be reamed fair and a size of rivet to fit the hole must be used. Countersinks must be not less in depth than three-fourth the thickness of the plate or angle bar countersunk. Rivets will completely fill their holes, the heads will be laid up in all water-tight work, and the points of rivets when finished will completely fill the countersinks and be flush or slightly convex with the surface of plates.

62. *Foundations of boilers.*—The requisite beams, fitted to camber of deck to carry the ash pan, and cradles for mud drums are to be securely riveted to deck.

63. *Foundation for capstans.*—Doubling plates ¼ inch thick are to be riveted to deck for base of capstans, and Z bars are to be riveted to deck beams and floors for engines, as shown on sheet 5.

64. *Other foundations.*—Such other doubling plates or special provision for the foundations of pumps, dynamo, throttle valve, and other machinery will be put in as the requirements of said machinery may demand, in a first-class and substantial manner. No oak packings will be placed in direct contact with metal of hull, but in all cases one or two thicknesses of tarred felt must be interposed.

65. *Cylinder beams.*—The cylinder beams are to be built in the form of a box girder, as shown on sheet 8, with the sides of 10.2 lb. plate, shaped as required, top connecting angles 3 in. × 3 in. × 7.2 lb. on the inside, and bottom angles 3 in. × 3 in. × 7.2 lb. on the outside, riveted to deck. The top is to be of 15.3 lb. plate throughout, but such doubling plates for cylinders, slides and crank shaft bearings, together with keying blocks for same, as may be required are to be furnished and riveted in place. The long cylinder beams are to extend 24 feet beyond transom; the top chord over transom is to be reinforced with double and triple plates of 15.3 lb. of lengths as shown on drawing. Beyond the transom the bottom angles are to be on the inside, and the inside and outside angles are to overlap each other at the transom about 7 feet. The bottom plate of projecting ends of beams is to be 15.3 lb. and to run inboard 3 feet from transom and to extend aft a distance of 12 feet. The length of inboard end of long beams and the whole length of short beams will be determined from the design of the engine. The plates will be in as long lengths as possible, and all joints of side plates will be double riveted butt, with double straps, each of 7.65 lb. plate. The joints of top plates will be treble riveted butt, with single straps inside of 15.3 lb. plate, wide enough to take in the angle bar rivets with a ⅜ inch filler between the flanges of angles. The beams will be stiffened by 2 in. × 2 in. × 3.2 lb. angle bars placed vertically, at a distance apart of 3 feet centers, and at each third pair a tie of 7.65 lb. plate will be riveted in. At the transom, the long beams are to be braced transversely by gussets of 15.3 lb. plate running aft 3 feet and landing 2 feet on transom-sheer angle. The short cylinder beam is to be of the same general construction and of the same form and height as the forward end of the long beam. Near the after end of slides the beams will be connected together by gussets of 7.65 lb. plate and 2½ in. × 2½ in. × 5 lb. angle bars, the free edges of plates to be stiffened by the same size angles. At the forward end of cylinder beams a piece of angle bar is to be riveted to deck to form a stop water, and a drain pipe is to be provided to carry water overboard. The handholes required for putting in bolts will be on the neutral axis of web plates.

66. *Fantails and pitman hatches.*—These will be made of plates and angles and of the sizes and form shown on sheet 8. The gunwale angle will be continued to the end of fantail. The deck is to be of 7.65 lb. plate, stiffened by 1¼ in. × ⅜ in. bars on top, and web and nosing plates are to be tied with 2 in. × 2 in. × ¼ in. angle bars. Hand railings of 1 in. pipe will be put around pitman hatches and also along the outside of engine room siding about 4 feet above guard.

67. *Wheel chains and braces.*—Two (2) braces, each made of two (2) 8 in. × 11 lb. channels 24½ feet long, tied together by lattice bracing, will stand on top of long cylinder beams and be attached thereto by gusset plates and angles. The upper ends are to be tied together by a brace made of 4 inch diameter extra heavy pipe with heavy flanges screwed or expanded on the ends, and bolted to channels. The upper ends will be reinforced with ¾ inch plates riveted on the inside, through which the chain pin will pass. The chains will be 1¾ inches in diameter, with 2½ inch turnbuckle in each length. The upper ends will have male and female joints hung from a 2½ inch pin in head of brace; the after rods will take hold of heavy strap forgings riveted on outer ends of cylinder beams; and the forward rods will take hold of same beams at a convenient point between cylinder and slide bars.

68. *Nosing.*—The nosing is to consist of a strake of white oak 6 inches wide and 8 inches deep, rebated to fit gunwale angle and made flush with deck and bolted to hull with ¾ inch bolts about 18 inches centers and staggered. The nosing will run all fore and aft and finish off at the fantail flush with cylinder beams. Joints are to be scarfed 3 feet long, and everywhere where the oak comes in contact with the metal a thickness of tarred felt must be inserted. A rubbing strake 4 inches thick and 8 inches deep will be fastened outside of nosing with ½ inch spikes. The nosing at bow will be in one piece 10 inches wide and 8 inches deep, fitted and secured in the same manner as above described. The round corners at bow will be banded with 6 in. × ½ in. iron, edges and ends properly chamfered and secured by ½ inch countersunk drift bolts. All edges of nosing will be properly rounded and finished in a neat and workmanlike manner.

69. *Stack and towing knees.*—There will be a pair of knees on each corner of the bow, made as shown on sheet 8. The front is to be of 12.75 lb. plate, to stand 3 feet high above deck, and to be continuous at this height around the corner between the two knees, and from thence to slope to deck, with a landing on deck of 24 inches from center of knees. These plates are to be attached to deck by 3 in. × 3 in. × 7.2 lb. angles riveted through deck to gunwale. Two knees in the positions shown will support front plate and are to be made of 12.75 lb. plate, connected to front and deck by 2½ in. × 2½ in. × 5 lb. angles. The free edges throughout will be stiffened by 2½ in. × 2½ in. × 5 lb. angles backed with 3-inch half oval iron and well riveted. Posts of white oak 9 in. × 9 in. will be bolted to face of front plates, standing 10 inches above same, to which the fenders will be lashed.

70. *Bitts, chocks, and cavils.*—The bitts on forward deck are to be made of white oak 12 in. × 12 in., standing 34 inches above deck and extending to shoe built on frames Nos. 3, 4, 5, and 6. The cavil is to be white oak, 10 inches deep and 12 inches wide, and will be notched 2 inches into bitts and securely bolted to same. Deck rings of 4 in. × 4 in. × 9.8 lb. angle bar will be riveted to deck, with the forward flanges set over deck beam No. 3. These rings will be welded at corners and made 1 inch larger all around than bitts, and the bitts will be securely wedged in same with dry oak wedges smeared with white lead paint. The chocks and cavils are to be steel castings, as shown in detail on sheet 4, and will be placed as shown on deck plan, sheet 6, and riveted to deck.

71. *Ring bolts.*—A ring of ¾ inch iron, 5½ inches outside diameter, will be secured at the foot of each derrick by a ⅞ inch U bolt, and similar ones will be placed on each side of boat abaft of bow chocks, as indicated on plan; also two of 1 inch iron at ends of cylinder beams.

72. *Stiffening plates.*—These will be riveted to deck under all chocks and cavils, and at other places which may require additional local strengthening. These plates will be ½ inch thick and riveted to deck independently of the chock or cavil which they carry.

73. *Hatches.*—Hatchways will be provided for access to the several compartments of the hold, and manholes will be cut in longitudinal bulkhead, as before described. The hatch covers are to be made of 5.1 lb. plate, with 1½ lb. angle bar rings and stiffeners on under side and with ring bolts for lifting. Iron ladders will be provided for each hatch.

74. *Rudder boxes.*—Two (2) rudder boxes will be built in the space between frame No. 113 and the transom, as shown in detail sheet 4. The boxes are to be made of 10.2 lb. plates and angles 2½ in. × 2½ in. × 5 lb., the base angles being riveted through deck and deck beam. The outward ends of front plate will be riveted to cylinder beam. The side plates will be continued up to the top of front plate as braces, and the free edges stiffened with 2½ in. × 2½ in. × 5 lb. angle bar. The boxes will be made water-tight below deck. Three (3) rudder bearings, to be first class forgings with large bases, will be riveted in each box to suit the position of pintle straps on rudder stocks, as shown on sheet 8.

75. *Rudders.*—Two (2) balanced rudders are required, each to be placed at a distance of 9 feet 6 inches from center line of boat. The rudder stocks are to be lap-welded tubes 8 inches in diameter and ⅝ inch thick, and 17 feet long, and will have three (3) grooves turned in each at the distance marked on sheet 8, to receive the

pintle bands. These bands are to be good sound forgings, and must be bored to fit the grooves snugly, sprung into place and securely bolted. Near the upper end of stock, cheek pieces, either forgings or steel castings, will be riveted on as shown. and will have a 2¼-inch hole bored through center to receive the tiller pin. At the upper extreme end a hole will be bored to receive the tiller brace. The blades of rudders will extend forward 11 feet, and will be shaped to fit the rake of hull; and on the after end they will extend 11 feet and will be shaped concentrically with paddle wheel. The blades are to be built of 7.65 lb. steel plates and 2½ in. × 2½ in. × 5 lb. angle bars. Pieces of 7 65 lb. plate will be bent to fit the stock and will be flanged on both sides and riveted to both the fore and after faces of stocks. Secondary stiffening plates will be riveted on the athwartship center line of stocks, and will fit close to and extend beyond the above flanged plates, both fore and aft. The plates of blades will be laid on these stiffeners and will be riveted thereto, then brought together at the fore and aft edges and riveted together with a 3-in. × ¼ in. bar inserted between. The side plates will be stayed throughout by ⅝ inch through rivets, with pipe ferrules inserted between. The bottom will be closed with a $\frac{3}{16}$ inch plate and outside angle bar 2½ in. × 2½ in. × 5 lb.; and finally, the top edge will be filled in with hard wood about 3 inches thick and riveted through and through. The rudders are not to be water-tight, and a number of ¾ inch holes will be punched in bottom plates. The pintle pin will be 1¾ inches diameter, and bronze washers will be inserted between all the lugs in order to insure a distribution of the weight of rudders on each bearing. Lifting shackles and bumpers will be provided.

76. *Tillers.*—Each tiller will be made of two (2) 4 in. × 1 in. bars, riveted together with separators between, as shown on sheet 8, and will have eyes forged at one end to couple to rudder stocks, and a ring at the forward end for attaching tiller ropes. The two tillers will be connected by a brace of 3-inch tube with pin joints at each end, and the weight of outer end will be sustained by a brace of 1-inch iron with upset thread, running to head of rudder stock. Any modification of the tiller ends that may be necessary to accommodate the steam steering rig will be made as required.

77. *Material and workmanship.*—The best quality of material and workmanship will be required in each and every part of the work done under these specifications. All plates and angles used in said work are to be of soft steel having an ultimate tensile strength of from 52,000 to 62,000 lb. per square inch, the elastic limit not less than one-half the ultimate strength, with an elongation of 26 per centum in 8 inches and a minimum reduction of area at fracture of 50 per centum. One test piece for tensile strength and one for bending shall be taken from the steel of each heat. For the bending test, the pieces will be bent cold 180 degrees flat upon themselves without fracture on the outside of bent portion. A variation of more than 2½ per cent above or below the specified thickness will be cause for the rejection of any material. Rivets will be tested cold by driving the shank into the head; the rivet must then be without sign of fracture on the outside edge. Facilities must be given to the inspector by the manufacturer and contractor for making these tests, the cost of which will be borne by the contractor.

78. *Testing of hull.*—The bottom of hull will be tested for water-tightness by filling with water to a depth of about 6 inches before the boat is launched, and all leaks and imperfections then discovered will be made good.

UPPER WORKS.

79. *Boiler deck house.*—The forward end will be about 21 feet 3 inches from bow, or so that stanchions will clear deck beam No. 14. The side bulkheads will have a width of 28 feet as far aft as the engine room, where they will widen out to 34 feet at forward end and conform to the run of the boat as it extends aft.

80. *Material.*—All lumber used in the construction of the upper works and in all other carpenter work must be first class, clear and well seasoned, free from sap wood and shakes, dressed on sides and edges, and of the sizes specified after being dressed.

81. *Framing.*—The main stanchions, except at sides of boilers, are to be of white oak, and in general 3¾ in. × 3¾ in., placed at a distance of about 8 feet apart. At the sides of the engine room the stanchions will be secured to deck by angle clips, but forward of this they will pass through deck and fasten to floor beams. Deck rings of angle bar or steel castings will be riveted to deck and stanchions secured by caulking in with oakum. The stanchions at boilers will be of 4-inch iron pipe secured to deck with cast-steel flanges, as shown on sheet 3. The intermediate stanchions are to be 1¾ in. × 3 in. white pine, spaced about 24 inches apart, and will be carried by sills of white pine 3 in. × 4 in., checked into main stanchions and supported in the middle by iron knees, riveted to deck. The two forward corner stanchions are to be white oak 5 in. × 5 in., and will extend through the boiler deck and stand about 4 feet above the hurricane deck for fastening of chimney guys. The fender stanchions at each side of engine room are to be white oak 10 in. × 8 in. at bottom

and 9 in.×7 in. at top, and will stand about 12 inches above boiler deck. The heads will be anchored back to carlins by strap bolts. The side stanchions will tumble in 3 inches at top.

82. *Clamps.*—The outside clamps are to be 1⅞ in.×10 in. white pine, and the inside clamps 1⅞ in.×6 in. white oak, checked into stanchions and bolted.

83. *Carlins.*—These are to be of 1⅞ in.×6 in. yellow pine, spaced about 18 inches apart centers, checked over clamps 1 inch deep. Each carlin will be in two pieces, overlapping 2 feet each side of center and bolted and nailed together, and extending outboard to form the boiler deck guard. The carlins will be doubled at bulkheads or where extra strength is needed.

84. *Stringers.*—Over the boilers there will be three (3) deck stringers, the center one 4 in.×6 in. and the side ones 4 in.×5 in. From the front of boilers to the splash bulkhead there will be two (2) stringers 4 in.×6 in. These are all to be of yellow pine in long lengths, with scarfs 3 feet long bolted and nailed, and secured to caps of stanchions by screw bolts.

85. *Stanchions and trusses.*—Besides the pipe stanchions on each side of boilers there will be another row between boilers on the center line of boat. These are to be of 4-inch iron pipe, secured to deck by cast-steel flanges, and the stringers will be carried on cast-iron caps fitted on top of stanchions, as shown on sheet 3. Between each pair of these stanchions a truss made of 3 in.×2½ in.×6.6 lb. angle bar and a 1-inch tie rod will be built to carry the side stringers, as shown on sheet 3. The other stringers will be carried by similar pipe stanchions at a general distance apart of about 8 feet centers.

86. *Boiler deck.*—This will be laid with yellow pine ⅞ inch thick, in strakes 3 inches wide, tongued and grooved and beaded on under side. The height of boiler deck from main deck will be 11 feet 6 inches, and the deck will have 4 inches of camber. The guards will be finished in the usual manner with facing 6 in.×⅞ in., nosing 5 in. ×⅞ in., waterway 4 in.×⅞ in., and under plank sheer 9 in.×1½ in., all of white oak. The outboard edge of guards will be supported by braces of white oak 2⅞ in.×4 in., running from under plank sheer to main stanchions. The boiler deck is to be doubled over the whole of the intermediate cabin between the two passages with yellow pine ⅞ inch thick in strakes 3 inches wide, slightly outgauged, caulked with cotton and payed with thick white lead.

87. *Siding.*—The deck house will be sided with white pine ⅞ inch thick, tongued and grooved and beaded on the outside, in strakes 3 inches wide, laid longitudinally except at round corners at bow, which will be vertical, The coal bunker will be sided on the inside with white or yellow pine 1¼ inches thick, tongued and grooved up to a height of 5 feet above deck. Doors, windows, transoms, and shutters will be put in where shown on drawings.

88. *Bulkheads.*—There will be a bulkhead aft of coal bunker over frame No. 68, and at engine room between frames No. 82 and No. 83, which will be built in substantially the same manner as the sides.

89. *Splash bulkhead.*—A coaming of 4 in.×3 in. white pine will be bolted to deck, running between cylinder beams and flush with outside of transom. The stanchions will be stepped on coaming and efficiently secured, and will have nailing rails between them. The bulkhead as far up as boiler deck will be sided with two thicknesses of ⅞-inch white pine, tongued and grooved; the first lay to have three (3) coats of pure white-lead paint before the second lay is put on, and the second lay to receive a coat of thick paint while being laid. Above the boiler deck the splash bulkhead is to be of ⅞-inch thick white pine, tongued and grooved, and will run above hurricane roof a height of 3 feet and be finished on top with a cap 2¼ in.×⅞ in. and with two side strips below of 2¼ in.×⅞ in.

90. *Stairs.*—The main stairs to boiler deck will be 4 feet wide in the clear, with oak treads 10 in.×1½ in. and pine risers ⅞ inch thick and about 8 inches high; and will be sided with ⅞-inch white pine, tongued, grooved, and beaded, and carried above deck to form a rail around well. Two stairs from boiler deck to roof will be built, the forward one to be over main stairway, 30 inches wide in the clear, with hand railing, and railing and hatch doors on roof; the after stair to be 24 inches wide in the clear and similarly fitted with railing and hatch doors. The after stairs from main deck to boiler deck will be located on forward side of engine-room bulkhead. They will be 3 feet wide in the clear, with oak treads 1½ inches thick and 9 inches wide, and will have railing around well. Seven (7) sets of steps from hurricane deck to skylight roof will be provided.

91. *Lockers.*—The usual hawser lockers on each side of stairway on forward deck, lamp room and mate's lockers, engine room lockers, and such other accommodations for ship stores as are usual must be provided.

92. *Water closets.*—At the splash bulkhead two (2) closets will be provided and fitted with soil pipes of suitable size and shape, made of steel plate ¼ inch thick, riveted to rake of boat, and passing through deck, to which they will be secured by rings of 2 in.×2 in.×3.2 lb. angle bar.

93. *Swinging fenders.*—The swinging fenders will be 8 in.×10 in. at bottom and 6 in.×10 in. at top. Those at the engine room will be lashed to heads of stanchions, and those forward of the engine room will be lashed to small iron cavils, which are to be secured to deck by ⅝-inch bolts passing through the under plank-sheer. These fenders will be long enough to reach within 4 inches of the 4-foot water line. The swinging fenders for stack knees will be 8 in.×11 in. at bottom and 6 in.×11 in. at top, and about 8 feet long. The fenders are to be of the best white oak or hickory.

94. *Derricks and spars.*—A derrick or mast of white pine 34 feet long and 9 inches maximum diameter, tapering to about 7½ inches at end, will be placed on each side of boat at forward end of boiler deck, stepped in cast-iron shoes riveted to deck. The top ends will be fitted with iron bands and eyes for guys, and the derricks will be secured by ⅝-inch wire rope guys to ring bolts in deck and forward stanchions. Two (2) spars about 11 inches maximum diameter and 36 feet long, properly dressed, will be provided and lashed in place alongside of masts.

95. *Engine room.*—Near the after end of engine room the usual bulkhead will be placed, and a vise, bench, lockers with all drawers, shelves, doors and locks, storerooms at splash bulkhead, and stands for oil tanks will be provided.

CABIN.

96. *General.*—The general arrangement of cabin will be as shown on plan, sheet 7. The forward cabin, containing officers' quarters, staterooms, office and messroom, will be 28 feet wide; the intermediate cabin, containing kitchen, pantry, storeroom, laundry, wash and bath rooms, will be 28 feet wide; and the after cabin, containing the crew's messroom and quarters, will be 22 feet wide. The skylight will extend the full length of the cabin at a width of 14 feet. There will be a passageway 4 feet wide between the forward and intermediate cabins, closed at each side by a door, so that the siding will be continuous as far as the end of the intermediate cabin. The distance between the intermediate and after cabin will be 6 feet on the starboard side, and here the after stairway will land, leaving a clear gangway of 3 feet. On the port side the laundress's room will extend 3 feet into the passageway, leaving a 3-foot gangway also on this side.

97. *Dimensions and material.*—The cabin outside stanchions are to be of poplar, 1 in.×3½ in.; the inside stanchions of poplar, 1¼ in.×3 in.; the plank-sheer of white pine, ⅞ in.×3½ in.; the outside clamps of white pine, 1⅛ in.×7 in.; the inside clamps, 1⅛ in.×5 in.; the carlins of poplar, 1 in.×4 in.; the bulkhead strips of poplar, 1 in.×1¼ in.; the panels of poplar, 5/16 in.; the margins of white pine, ⅝ in.; the roof facing of white pine, ⅞ in.×4 in.; the nosing of white pine, ⅞ in.×4 in.; the waterway of white pine, ⅞ in.×2 in. The skylight clamp is to be of white pine, 1⅛ in.×8 in.; carlins of poplar, 1⅝ in.×5 in.; facing of white pine, ¾ in.×4 in.; nosing of white pine, ½ in.×3 in.; waterway of white pine, ¾ in.1×½ in.

98. *Construction.*—The cabin and skylight roofs are to be of ⅞-inch white pine, tongued and grooved and beaded on under side and double nailed to each carlin. The height of cabin from carlin to carlin will be 8 feet, and the general construction will follow the ordinary river practice. The cabin ceiling will be paneled with an OG moulding; the skylight carlins will be capped on under side; a plain cornice will extend the full length of the skylight, and the forward cabin will be finished with pilasters on each side of doors and plain brackets to cornice. All rooms will have transom sash on the outside, and those in forward cabin will have transoms inside also. The intention is to have all the joiner work done in a thoroughly good and substantial manner and neatly but plainly finished. The cabin will have four (4) ⅝-inch bolts on each side, passing from carlins to under side of boiler deck carlins.

99. *Pilot house.*—This will be 13 feet long fore and aft, 13 feet wide, and 12 feet 6 inches high. The floor beams will be 1¾ in.×10 in., spaced about 18 inches centers, carried on rails 1¾ in.×6 in. on each side of house. The floor is to be of ⅞-inch yellow pine, tongued and grooved. The corner stanchions will be 3 in.×3 in., and the siding is to be of white pine ⅝ inch thick, tongued and grooved and beaded on both sides. The pilot house will be fitted with the usual adjustable sight shades in front, and with sliding sashes on the other three sides. The sashes will be 1⅝ inches thick and mounted with rollers on brass water tables. A door 30 inches wide will be provided in after side of pilot house, with suitable steps to same. The pilot house will be securely fastened down by a ⅝-inch bolt at each corner stanchion.

100. *Water tanks.*—A combined water tank and filter 9 ft.×3 ft.×20 in. deep, made of galvanized iron No. 12 B. W. G. and fitted with iron covers, will be provided for the cold-water service, and a tank of similar size and make, but fitted with a steam-heating coil, will be provided for the hot-water service. Both of these tanks will be placed under the floor of pilot house. A small expansion tank will be placed in kitchen where convenient, and will receive the water of condensation from coil in hot-water tank, and will also have a connection to filter tank operated by a ball valve. This tank will work in connection with the boiler of cooking range. The hot and cold

water tanks will be supplied by the fire pump, and all connections, valves, and overflow pipes necessary for the complete fitting out of this service will be provided.

101. *Pilot wheel.*—This will be 10 feet in diameter over all, with double rim of usual construction and mounted in the usual manner. The barrel will be 15 inches in diameter; and the necessary tiller ropes ¾ inch in diameter, with all sheaves and sheave boxes, will be provided and fitted in place in a first-class manner. The fittings in pilot house will include speaking tube to engine room, bell tube, bell stand, all necessary bell pulls and bell cranks, and wiring to engine room and whistle; also a settee with drawers underneath.

102. *Roofs.*—All roofs will be covered with 10 oz. canvas duck, U. S. Army standard, well lapped at edges and secured with 10 oz. copper tacks, laid on a thickness of heavy roofing felt and painted with two (2) coats of pure white lead, ground in boiled linseed oil and toned to lead color with lampblack.

103. *Guard rail.*—This will extend all around the boiler deck. It will be made with stanchions of white oak, 1¾ in. × 1¾ in., spaced about 6 feet apart centers, with one short stanchion of white pine between. The rail will be 29 inches high. The caps are to be of white pine ⅞ in. × 4 in., with filling on each side of stanchions ⅜ in. × 2 in., and two rails of white pine ⅝ in. × 2 in.

104. *Doors.*—All doors are to be made of white pine; those 27 inches wide and under to be 1 inch thick and those above 27 inches wide to be 1¼ inches thick. Inside doors will be paneled and outside doors will have the lower part paneled and the upper part glazed. All stateroom outside doors will be fitted with blinds of white pine ⅝ inch thick. The doors will be hung with steel loose-pin butt hinges and fitted with rim locks and white porcelain knobs of extra good quality, and all necessary brass hooks and eyes of ship-cabin pattern. The blinds to outside doors will have 2½-inch brass shutter bars with brass hooks and eyes for fastening back. The sliding doors on main deck will be mounted with "Run Easy" warehouse hangers with 6-inch wheels and 1¾ in. × $\frac{5}{16}$ in. rails, and will be fitted with flush door handles and suitable locks.

105. *Windows and transoms.*—The windows will be single sash 1⅛ inches thick, and transom and skylight sash will be 1 inch thick. The windows will be made to drop on inside of bulkheads and will be fitted with slides and water tables, sash weights, pulleys, cords, and fastenings. The transom sash will be hung at top, the skylight sash at bottom, and all will be provided with the necessary buttons, chains, hooks, and spring bolts. All glass used is to be double strength "American," and sashes must in all cases be made to use lights of standard size. All hardware furnishings must be approved by the engineer officer in charge.

106. *Forward cabin and staterooms.*—Each of the eight staterooms in after part of cabin will be fitted with a locker 32 inches wide and 18 inches deep, with two (2) drawers below and paneled doors in two parts above, and provided with drawer pulls, hinges, spring catches, and six (6) heavy clothes hooks to each locker. Lockers are to be built in cabin abreast of chimney casings. Each locker will be in two sections, with two drawers below and paneled doors in two parts above, and fitted up with three (3) tiers of shelves, drawer pulls, doorknobs, hinges, and locks and keys for all drawers and doors. The floors of office, officers' mess, and all staterooms in forward cabin, also floor of pilot house, will be covered with linoleum. Iron bedsteads will be furnished throughout the boat, as hereafter specified.

107. *Kitchen, pantry, etc.*—The kitchen will be fitted with fixed tables, placed as shown on plan, and the pantry will have a wash table, four (4) tiers of shelves, and drawers. Both storerooms will also be fitted with shelving in a complete manner, a baker's table as shown, and the doors will be fitted with first-class locks.

108. *Laundry.*—The laundry will be furnished with an ironing table 24 in. × 36 in. on top, made of white pine, and the laundress' room will have linen lockers placed above the bed.

109. *Crew's mess room.*—This will be furnished with two plain tables 3 ft. × 7 ft., made with pine frames and hard-wood tops; also four seats 7 feet long to suit same.

110. *Ice box.*—An ice box of first-class construction, charcoal filled, will be placed in after passageway and fitted with drain pipes.

111. *Crew's water-closet.*—Two (2) closets will be built at splash bulkhead, and the upper panel of doors will be lattice.

MACHINERY.

112. *Main engines.*—The engines are to be of the usual Mississippi River type, and must be built of ample strength for working under a steam pressure of 200 pounds per square inch. Special attention must, however, be given to reducing weights as much as possible, consistent with strength required. The engines must be of simple design and have large wearing surfaces, balanced valves, and variable cut-offs, both of types approved by the engineer officer in charge, and must have such modern improvements as are applicable to the design. They must be well fitted and neatly finished throughout, though a large amount of bright work will not be required.

113. *Cylinders.*—These will be of 22 inches diameter and 8 feet stroke, sufficiently thick to permit of two or three reborings, cast in dry-sand molds of hard, close-grained iron, very smoothly bored, counter-bored ¼ inch at each end short of the travel of the piston packing. rings, and must be entirely free from blowholes and spongy places. They must be first class in every respect, and will be fitted with the usual side pipes, valve boxes, valves and gear, also automatic drain cocks; and will be covered with approved magnesia nonconductor and lagged with planished sheet steel about No. 14 gauge. The cylinders will be fastened to beams without cast-iron bed plates.

114. *Piston rods.*—These are to be of hammered steel. The piston heads and followers are to be steel castings, with cast-iron bull and packing rings. The rod will be fitted into piston against a shoulder, and into the cross head against the end, with only sufficient taper to enable cross head to be removed without driving. A backing cutter will be fitted to rod. Metallic packing of make approved by the engineer officer in charge will be used in stuffing boxes for piston rods.

115. *Cross heads.*—These are to be preferably of steel castings, and will be fitted with bronze gibs in the usual manner.

116. *Slides.* These are to be fine, close-grained cast iron, truly finished, and will be fitted directly to cylinder beams without cast-iron bed plates.

117. *Pitmans.*—These will be 40 feet long centers, and are to be built of iron or steel lap-welded tube, with solid stub ends inserted and efficiently trussed. They will be fitted with brasses lined with best babbitt metal, and gibs and keys.

118. *Shaft and cranks.*—These are to be of hammered steel, well designed, and will be fitted up in accordance with modern practice. Five (5) wheel flanges hooped with wrought-iron bands will be firmly keyed on shaft.

119. *Pillow blocks, etc.*—The pillow blocks, yokes, cams, and cam brackets, and all other details, will be designed and fitted in accordance with best practice.

120. *Throttle valve.*—This will be of good design, mounted on stand with rollers, in the usual manner.

121. *Operating gear.*—The engines will be handled from throttle valve stand in the usual manner. The reversing and cut-off shafts and levers will be below the deck, and a steam reversing cylinder will be provided, with all working handles and lifting rig neatly arranged.

122. *Bells.*—Two (2) signal bells of distinct tone, one 12 inch and one 8 inch, will be set up in engine room; and one 12-inch gong and also one 8-inch gong in fire room; all to be connected and wired as required.

123. *Wheel.*—The wheel will be 24½ feet in diameter over ends of arms, and will have five (5) sets of arms, 16 arms to the set. The buckets will be 1⅞ inches thick, 34 inches wide, and 24 feet long, with balance buckets as required. The arms will be 6½ inches at flange, 11 inches at circle, by 2¾ inches thick. Beyond the circle the back of arm will be tapered to 8 inches at point. The circle segments will be 7 inches wide, and will be set up with keys and secured with iron ring on each side 5 inches wide and $\frac{3}{16}$ inch thick, bolted with three (3) ⅝ inch bolts to each segment. Two sets of braces will be fitted in between circles and flanges. Battens will be 32 inches long, 8 inches wide, and 1½ inches thick. Stirrups will be made of ⅞ inch square iron, with large square nuts and double washer plates of 3 in. × ½ in. iron. All lumber for wheels is to be seasoned white oak, except braces, which are to be pine or poplar.

124. *Designs for engines.*—Bidders are required to submit designs and specifications for main engines, subject to the conditions herein specified, as it is intended that contractors may use existing patterns if desired. Any slight modification of the cylinder beams that may be desired by the contractor will be allowed if it does not interfere with any of the other work on the boat.

125. *Alternative designs.*—As it is the purpose of these specifications to obtain for the United States boats of large power, with a fair amount of economy, bidders are invited to submit alternative designs for compound engines of the same power as the high pressure engines herein called for, together with specifications and a comparison of weights and efficiency of the two types.

126. *Boilers.*—There will be six (6) main boilers of the usual Mississippi River type, of 38 inches mean diameter and 30 feet long, each boiler having two flues of 14 inches outside diameter. The boilers will be built in accordance with the rules of the Board of Supervising Inspectors of Steam Vessels, for a working pressure of 200 pounds per square inch. The shells are to be of marine steel $\frac{34}{100}$ inch thick and 62,000 pounds tensile strength. All holes will be drilled and longitudinal seams will be double riveted. The rings will be as long as practicable, and the longitudinal seams will be above the fire line. The flues are to be of lap-welded tube in 3 foot sections and $\frac{33}{100}$ inch thick, the joints carefully and tightly fitted into each other in a thoroughly first-class manner. The boiler heads will be annealed after flanging; the back heads will have full-sized manholes at top, and front heads will have large hand-holes at bottom. Manhole doors are to be "Eclipse" or other equally good.

127. *Casings, breeching, and chimneys.*—The boilers will be set in two separate batteries, and will have neat, substantial cast-iron fronts, fitted with fire, poker, and ash doors, grate bars and bearers. The casings are to be made of sheet steel No. 12 B. W. G., strengthened with angle-iron flange around top edge and at sides and bottom, and will be provided with all side stays and bottom stands necessary. The breechings are to be of good design, made of sheet steel No. 8 B. W. G., and adequately supported. The chimneys will be 36 inches in diameter and 50 feet high above grate bars, and are to be made of sheet steel, the lower half No. 12 B. W. G., and the upper half No. 14 B. W. G., and will be strengthened with three (3) angle bars 2½ in. × 2½ in. × 4 lb., running full length on the inside. The tops of chimneys will be finished with a 3 inch angle-iron ring, and all eyebolts, guy rods, turnbuckles, and fastenings will be provided. The usual casings from boiler to hurricane deck are to be made of sheet steel No. 16 B. W. G., and will be fitted in place with proper deck rings and umbrellas in a thoroughly first-class manner.

128. *Steam and mud drums.*—Each battery will have a steam drum 28 inches in diameter and 11 feet long, connected to each boiler by legs 10 inches in diameter and 6 inches long, double riveted to each. Manholes and doors, similar to those on boilers, will be put in inboard heads. A main steam branch 9 inches in diameter will be riveted on each drum, and a dry pipe, as shown on sheet 3, will be fitted on the inside. Steam branches for auxiliary lines and reinforcing plates will be put on as required. Two mud drums 16 inches in diameter and 11 feet long for each battery will be connected to each boiler by legs 8 inches in diameter, double riveted. A handhole 7 inches by 9 inches will be put in each head as near the bottom as practicable.

129. *Brick work.*—The furnace and bridge wall below the grates will be built of "Extra" fire brick, and the furnace walls above grates, the fire bed and side walls for half the length of boilers, will be "XXX," and the remainder of the work "Extra." The covering tiles will be 2½ inches thick and of the best quality. The ash pans will be lined with split hard pressed red brick, well grouted. The whole of the setting is to be done with the best quality of fire clay.

130. *Fittings and valves.*—The boilers will be furnished with all the usual and necessary fittings. Each boiler will have one spring-loaded safety valve, mounted on a flanged branch riveted to shell. There will be three (3) try cocks in each wing boiler of each battery and two (2) in the center boiler; feed and check valves for each battery; a relief valve loaded to 220 pounds per square inch, placed on feed pipe line; two (2) 2 inch blow-off valves to each mud drum, each pair to be connected to one pipe leading overboard below deck and fitted with elbows on outside of hull; one main steam valve 8 inches in diameter for each battery; and all auxiliary valves for other steam branches. All valves for steam and feed, or that are under high pressures, are to be "extra heavy" and adapted to the purpose for which they are to be used. All valves 2½ inches and under are to be entirely of brass, unless otherwise permitted by the Engineer Officer in charge for special requirements, and in no case will the ordinary light commercial valve be accepted. It is advisable that uniformity in the make of valve be maintained as closely as possible, especially of such as have renewable valve disks. All fittings must be approved by the Engineer Officer in charge.

131. *Steam pipes.*—All steam and feed piping will conform to the rules of the Board of Supervising Inspectors of Steam Vessels. The main steam branches from steam drums will be 8 inches in diameter, connecting by a T on center line of boat and running thence 9 inches in diameter to throttle, and from throttle to engines in two branches 7 inches in diameter; all to be lap-welded tube with steel flanges riveted on. All bends in these pipes will be of large radius and very neatly bent. The auxiliary steam line is to be of lap-welded tube 3 inches in diameter, and will be connected with auxiliary boiler, capstans, fire pump, syphons, and electric-light engine. All pipes 2 inches and over will be connected by flange couplings as far as possible.

132. *Exhaust pipes.*—Exhaust pipes from engines to heaters, and to atmosphere, will be 8 inches in diameter; the branches outboard through splash bulkhead 6 inches in diameter, and from heaters to chimney 7 inches in diameter. Valves will be provided both at cylinder end and at chimneys to regulate the exhaust. The two lines of exhaust will be connected at boilers so that either chimney blast can be cut off when one battery of boilers only is in use. A separator will be made in each exhaust just before entering the chimney, with drain pipes overboard. The exhaust pipes are to be made of sheet steel, No. 12 B. W. G., with copper flanges about No. 8 B. W. G. at joints. The exhaust pipes through the roof will be enlarged to 10 inches diameter and carried 12 feet high above skylight roof and secured with wire rope guys.

133. *Steam gauges.*—The engine-room gauge will have a 12-inch face, each boiler gauge an 8-inch face, and auxiliary boiler gauge a 6-inch face; all to be fitted with brass cases, syphons, and drain cocks.

134. *Boiler and steam pipe coverings.*—The tops of boilers and steam drums, and legs will be covered with magnesia block of approved quality 2 inches thick, prop-

erly wired and covered with canvas where necessary. All steam pipes will be covered with approved magnesia block of the regular thickness, and the exhaust pipes from engines to heaters will be covered with approved magnesia block of half the usual thickness; all to be neatly finished at the flanges, connections, and joints, and banded.

135. *Feed pumps.*—Two (2) feed pumps will be required, each of sufficient capacity to supply both batteries of boilers when running at a piston speed of 60 feet per minute, and the pipe connections must be so arranged that either pump can supply either or both batteries of boilers. These pumps are to be of the vertical duplex type, with outside-packed plungers, of a make to be approved by the Engineer Officer in charge, and must be fitted with bronze bushes in glands and stuffing boxes, sight-feed lubricators, oil cups, etc. The suction will be taken from both sides of the boat, and will be provided with bells, shut-off valves, and screens. The feed pumps will be placed on center line of boat at forward end of bunker, and will be enclosed in a sheet-steel casing, with sliding doors in front. Two (2) stanchions of 3 in. × 3 in. × 7.2 lb. angle bar will run from main deck to carlin stringers, and on these the casing of ⅛-inch steel plate will be built as indicated on plan, Sheet 6. All stiffeners and angle bars for securing pumps will be placed where necessary.

136. *Heaters.*—Two (2) heaters will be required, the shells being an enlargement of the exhaust pipes; and will be fitted with cast-iron heads having stuffing boxes for feed pipes. The feed-pipe coils will be of ample size and will be fitted up in the usual manner. The feed will enter boiler from the top near the back end, make two (2) turns the length of the boiler, and discharge into center leg of back mud drum.

137. *Fire pump.*—This pump is to be of the horizontal duplex type with outside packed plungers, of make approved by the Engineer Officer in charge, and must have a capacity of at least 100 gallons per minute, delivered at a pressure of 125 pounds per square inch, when running at 100 feet piston speed. A fire pipe line will run on each side of boat and will have three (3) branches on each side on both main and boiler decks, and one on each side of hurricane deck. It will be furnished with 2-inch valves, brass couplings for 2-inch hose, hose key to each branch, and hose reels. Eight (8) lengths of 2-inch rubber-lined cotton hose, each 50 feet, and four (4) nozzles will be provided. The fire pumps will be connected to mud drums of main boilers and to water tank in pilot house, and will also have an independent hose connection.

138. *Capstans.*—Three (3) double-barrel steam capstans will be required, two (2) to be placed on forward deck as shown on Sheets 5 and 6, and one aft of cold storage in carpenter's shop. These capstans are to be "Providence" No. F, with double engines having cylinders 7 inches in diameter and 8 inches stroke, all gearing of steel, and shaft of large diameter. The engines of the port capstan will be secured under the deck, and those of the starboard and after capstan will be placed on floor. The steam valves for operating the capstans will be in the most convenient position to be handled from the deck, and all lubricators, oil cups, steam, exhaust, and drain pipes will be provided.

139. *Steam steering rig.*—This is to be of a design approved by the Engineer Officer in charge, and must be as simple as possible, easily handled, must not interfere with the use of the pilot wheel, must be quickly disconnected, and must be first-class in every respect.

140. *Bilge syphons and pipes.*—A 2½ inch bilge syphon will be placed in each water-tight compartment, and will be fitted with all necessary valves, piping, and suction screens. The steam valves will be placed conveniently for handling from main deck. The discharge pipes will be attached to hull plating by flanges, either bolted or riveted, and those pipes which are less than 18 inches above the water line will have swing check valves close to hull plating. All other pipes discharging through the sides of hull, above 1 inch diameter, will be attached by flanges, and smaller pipes will be connected with lock nuts.

141. *Electric-light plant.*—This installation is to consist of a direct coupled engine and generator of the multipolar type, 110 volts and necessary capacity. The engine is to be horizontal with automatic governor, and a reducing valve will be supplied for reducing the boiler pressure of 200 pounds as may be needed. A marble or slate switch board will be placed in the engine room and will be fitted with ammeter, voltmeter, rheostat, pilot lights, and switches for three (3) circuits, one circuit for main deck, one for cabin deck, and one for search and arc lights. The search light will be 18 inches, of 4,000 candlepower. It will have both revolving and deflecting movements and will be set at forward end of hurricane deck, and arranged to be operated from the pilot house. Two (2) arc lights of 1,200 c. p. each will be provided, one to be hung from a swinging spar placed forward on boiler deck and long enough to light either guard, and the other to be hung from a short spar placed over the wheel. The spars will be properly rigged with tackle and guys, and the lights will be arranged to be operated from the pilot house. Sixty (60) incandescent lamps will

be required, to be distributed as follows: The forward cabin will be furnished with two (2) combination electroliers, each arranged with three (3) sockets and three (3) coal-oil lamps, one bracket lamp in each stateroom, and 2 table lamps—20 lights in all; the intermediate cabin will have one bracket lamp in each passageway, one in each bathroom, one in laundry, one in laundress's room, one hanging lamp in each storeroom, pantry, and kitchen, and also one combination electrolier with one socket and one coal-oil lamp—a total of 12 lights in all; the after cabin will be furnished with one bracket lamp in cook's room, one in waiter's room, 2 hanging lamps in crew's mess room, 2 hanging lamps in crew's quarters, one bracket lamp each in bath and wash room and in closets at splash bulkhead—making 9 lights in all; the main deck will be lighted with one lamp in each closet, 5 in engine room, 2 in carpenter's shop, 2 in bunkers, one in front of boilers, 2 over boilers, 2 in forward storeroom, and one in each capstan hold, or 17 in all. These lamps are to be bracket or drop lamps, as may be required; some of them will require to be on long wires so as to be movable, and a few will require wire guards. Such sockets as can be easily reached from the deck are to be key sockets, and all others are to have switches at convenient places for handling. The lamps in cabins are to have suitable shades and will be set up in a first-class manner. Two (2) lamps of 32 c. p. each will also be furnished for chimney signal lights, with proper colored globes and suitably mounted in place, the switch to be located as required. All wiring in the forward cabin and staterooms will be concealed in a neat moulding, which is to receive one coat of white lead paint before being put in; all wires passing through bulkheads will be enclosed in porcelain or hard rubber tubing. All insulators are to be of porcelain, and the wiring and fittings generally will be in accordance with the rules and requirements of the National Board of Fire Underwriters. The engine and generator will have at least 20 per cent more power than absolutely required for the above-specified service, and all parts of the electric-light plant must be of approved pattern.

142. *Auxiliary boiler.*—This boiler is to be of the vertical submerged tube type, 42 inches in diameter and 9 feet high, with shell extended to form ash pan. All the plates used in the construction of this boiler are to be marine steel of not less than 62,000 pounds tensile strength. The shell will be $\frac{37}{100}$ inch thick, the fire box and cone will be $\frac{31}{100}$ inch thick, and the heads $\frac{37}{100}$ inch thick. The shell will be double riveted in the longitudinal seams, and all holes will be drilled, and the fire box and cone will be efficiently stayed for a working pressure of 200 pounds per square inch. The boiler is to contain about 100 tubes 2 inches in diameter and not less than 42 inches long, and must be built according to the rules of the Board of Supervising Inspectors of Steam Vessels. A chimney of suitable size will be provided, with all the necessary casings, deck rings, and guys, and the boiler will be set in place, all mountings fitted, and shell covered with approved magnesia nonconductor 2 inches thick, covered with canvas and painted. The bottom of the shell will have a 2 inch angle bar ring riveted on the outside and to the base plate, which last is to be made of ½ inch steel plate, square in form and flanged on all four sides about 3 inches deep, with a return flange outwards of 2 inches width by which the boiler will be secured to deck. The bottom of the ash pan will be lined with brick. The boiler will have three (3) mud ports at the bottom and three (3) on the level of the furnace crown, and will be provided with grate bars, glass water gauge, three (3) gauge cocks, one (1) 6 inch diameter steam gauge with brass case, spring safety valve, blow-off valve, one (1) 1 inch Metropolitan injector or other of equally good make fitted to boiler by connection independent of blow-off, and one (1) 2½ inch main steam valve of "extra heavy" pattern.

PLUMBING AND TINNING.

143. *Staterooms.*—Each of the four staterooms forward will be fitted with marble-top wash basins, slabs 20 in. × 28 in. with 10 inch backs, 14 inch basins, nickel-plated iron brackets and nickel-plated brass faucets for hot and cold water.

144. *Officers' wash room.*—This will be fitted with three (3) iron enameled washbowls, with sectional slabs, with brackets and union strips nickel plated, and nickel-plated faucets for hot and cold water.

145. *Bathrooms and closets.*—A 5½ foot white enameled roll-rim bath tub will be fitted in each bathroom, with nickel-plated faucets for hot and cold water, and other accessories, complete. Two water-closets will be fitted with earthenware front outlet, plain pedestal bowl, 7 gallon copper-lined siphon flush tank, with nickel-plated flush and supply pipes and double-cover seats. The woodwork is to be oak, and plain round cornered.

146. *Crew's wash room.*—This will be fitted with four (4) iron enameled washbowls, with sectional slab, similar to those prescribed for officers' wash room.

147. *Crew's bathroom.*—This will be furnished with a 5½ foot iron enameled roll-rim bath tub and fittings, similar to those in officers' bathrooms.

148. *Crew's closets.*—Each closet will be fitted with an earthenware urinal, discharging through splash bulkhead and having a zinc flushing trough on the outside.

149. *Sinks.*—One iron white enameled sink 40 inches × 20 inches will be placed in pantry, one 30 in. × 20 in. in kitchen, and one 30 in. × 20 in. in laundry; each to be fitted with hot and cold water connections, waste pipes, and brackets for supporting sinks. Traps will not be required for kitchen and pantry sinks, but the waste pipes must be of large size and be run overboard by an independent connection.

150. *Main deck closets.*—Each closet will be fitted with an earthenware urinal, discharging through splash bulkhead and having a zinc flushing trough outside.

151. *Engine room.*—One iron enameled washbowl and slab, fitted with nickel-plated faucets for hot and cold water, drainpipe overboard, and all other accessories, will be placed in engine room, as shown on sheet 6.

152. *Workmanship.*—All plumbing and pipe fitting will be done in the most workmanlike and sanitary manner, and will be a thoroughly first-class job in every respect. All cold-water service pipes will be connected with tank on roof, and the hot-water service pipes for all baths and wash rooms will be connected to hot-water tank under pilot house.

153. *Tinning.*—Four (4) down spouts from the corners of the pilot house, 1½ inches in diameter; five (5) on each side from skylight roof to hurricane deck, 2 inches in diameter; five (5) on each side of hurricane deck to boiler deck, 2½ inches in diameter, and five (5) swinging scuppers on each side of boiler deck, 3 inches in diameter, will be provided; all to be made of galvanized iron not less than No. 22 B. W. G. The necessary speaking tubes, bell tubes, and trumpets will be provided and fitted up in a complete and first-class manner.

MISCELLANEOUS.

154. *Painting.*—All woodwork above main deck will be painted three (3) coats of pure white lead and boiled linseed oil. The interior of cabin will be painted with one coat of shellac, three (3) coats of flat color, and one of zinc gloss. All knots will receive one coat of shellac. Three (3) name plates for sides of pilot house will be provided, having the name of boat in gilt letters on a dead black ground. The lettering on other parts of boat will be done as directed. In painting metal work all scales and traces of oxidation must be removed before applying the first coat, and all parts of hull will receive a coat of red lead and oil before or when being put in place, to prevent rusting. The outside of hull will receive two more coats of red-lead paint before launching, and the inside will receive one more coat of similar paint after all work is finished and the bilges cleaned out. The machinery and other ironwork will receive two coats of good oil paint of such colors as may be selected, the last coat to be put on after all work is done and preliminary tests are made.

155. *Lifeboats.*—Two lifeboats will be provided, each 16 feet long, made of No. 12 B. W. G. galvanized steel, in accordance with the rules of the Board of Supervising Inspectors of Steam Vessels.

156. *Boat davits.*—Two pairs of iron boat davits will be supplied and set in place and provided with foot steps, deck straps, blocks and falls, complete. Cradles will be made and set in place on hurricane deck for receiving lifeboats.

157. *Life buoys.*—Two cork ring buoys, 27 inches in diameter, will be supplied and placed, one on each side of boat.

158. *Anchor.*—One stockless anchor of approved make of about 700 pounds weight will be supplied.

159. *Ship's bell.*—A bronze bell, about 24 inches in diameter, mounted on an iron frame, will be set on the forward part of hurricane deck and arranged to be rung from either main deck or pilot house.

160. *Whistle.*—The whistle will be 8 inches in diameter, long bell, and will be placed on the center line of the boat near the chimneys. The steam pipe will have an independent connection to both boilers, with a shut-off valve to each. The whistle valve will be placed where most convenient and wired to pilot house.

161. *Jack staffs.*—A jack staff will be stepped outside of rail at forward end of boiler deck, and will stand about 20 feet above the roof. The after staff will be fixed to splash bulkhead, and both will be provided with halyards and cleats.

162. *Fire pails.*—Four (4) stands for fire pails will be provided and set on the skylight roof, each containing six (6) best galvanized-iron fire pails, large size.

163. *Stoves.*—One plain heating stove with square base and about 18 inches fire pot will be placed in office, and one of similar make with about 20 inch fire pot will be placed in officers' mess room. These stoves will be set on zinc stands, and will be secured to deck. A kitchen range must be provided, of wrought steel and of approved make, large enough to cook for about 30 persons. It must have two ovens and single shelf, pouch feed door for soft coal, and water back, and must be furnished with one 66-gallon pressure boiler, one set of waffle irons, 4 steel-ribbed roasting

pans, and 4 Russia-iron bread pans. The laundry must be provided with one wrought-steel stove, to heat 4 irons each side. All the stoves are to be adapted for soft coal, and will be set up in place with smooth stovepipes, and roof ventilators, and have housings, smokestacks, and caps of No. 22 galvanized iron. The chimneys will be so arranged and of such height as not to be an inconvenience to the pilot house.

164. *Steam heating.*—A complete system of steam heating will be installed, with coils as follows: Two (2) in office, four (4) in officers' mess room, one in forward passage, one in each forward bathroom, one in crew's mess room, two (2) in crew's quarters, one each in crew's bath and wash rooms, and one in pilot house. The length and numbers of returns of coils will be regulated by the size of rooms to be heated. A reducing valve will be placed near to boiler to reduce the pressure in heating system to about 25 pounds per square inch; and a spring loaded relief valve will be placed near end of main line of pipes in engine room, and also a pressure gauge in engine room. The whole will be fitted with all necessary radiator valves, air cocks, steam strap, drainpipes, and screens to protect the woodwork.

165. *Bedsteads and mattresses.*—Each of the six staterooms forward will be furnished with a white-enameled iron bedstead of plain design, 3 feet wide, and with pillars $1\frac{5}{16}$ inches, with an all-metal, steel-wire center support, woven-wire mattress to suit. Each of the other six staterooms in forward cabin will be furnished with a two-story all-iron bedstead, white enameled, 2 feet 9 inches wide, and with pillars $1\frac{1}{16}$ inches, with all-steel wire mattress to suit. The laundress' room will be furnished with a single all-iron bedstead, black enameled, 2 feet 9 inches wide, and with pillars $1\frac{1}{16}$ inches, with all-steel wire mattress to suit. The cook's and waiter's rooms and the crew's quarters will be furnished with ten (10) two-story all-iron bedsteads, black enameled, 2 feet 9 inches wide, and with pillars $1\frac{1}{16}$ inches, with all-steel wire mattress to suit. All bedsteads must be of approved make.

166. *Tools.*—All tools as per the following list will be supplied, and must be of approved make, unless otherwise specified:

1 set of firing tools for each battery of boilers.
1 set of firing tools for auxiliary boiler.
6 short-handled coal shovels.
2 long-handled coal shovels.
1 set of drop-forged steel wrenches for main engines.
1 set of drop-forged steel wrenches for feed pumps.
1 set of drop-forged steel wrenches for capstan engines.
2 machinists' hand hammers.
12 machinists' chisels, assorted.
1 twelve-pound sledge hammer and handle.
1 six-pound sledge hammer and handle.
1 boiler ratchet (12 inches).
6 steel drills for boiler ratchet, ⅜ in. to 1 in. by eighths.
1 grindstone, 36 in. × 3 in., mounted.
1 medium-size melting ladle.
1 small-size melting ladle.
1 portable forge, Buffalo No. 4.
1 machinists' parallel vise, 5½-inch jaws, Prentiss or equal.
1 pipe vise, hinged, to take pipe up to 3 inches diameter.
1 No. 1 Barnes 3-wheel pipe cutter.
1 No. 2 Barnes 3-wheel pipe cutter.
1 set of pipe taps, ¼ in., ½ in., ¾ in., 1 in., 1¼ in., 1½ in., 2 in.
1 No. 3½ duplex adjustable die stock, with dies from ½ in. to 2 in.
2 pairs No. 1 adjustable pipe tongs.
2 pairs No. 2 adjustable pipe tongs.
2 pairs No. 4 adjustable pipe tongs.
1 No. 3½ Brock's chain tongs.
1 six-inch Stilson wrench.
1 ten-inch Stilson wrench.
1 eighteen-inch Stilson wrench.
1 six-inch Coe's monkey wrench.
1 twelve-inch Coe's monkey wrench.
1 eighteen-inch Coe's monkey wrench.
1 brass oiler set (6 pieces).
2 oilers, steel, long spout, quart.
2 oilers, steel, long spout, pint.
2 oilers, steel, 3⅜ inches diameter, 3-inch nozzles.
2 galvanized iron oil tanks, 60 gallons, with pumps, measures, and funnels complete.

167. *Refrigerating plant.*—Separate bids are required on the refrigerating plant, which will have a capacity sufficient to make about half a ton of ice per 24 hours

and cool a storage room about 13 feet long, 6 feet wide, and 7 feet high in the clear. All the machinery necessary must be furnished and installed in a satisfactory manner. The freezing tank will be provided with ice molds and filter, and tank and cold storage room will be built in approved manner. The machine will not be run continuously, but in periods of 6 or 8 hours, with the same stoppage between runs. The plant will be tested satisfactorily for four (4) days before being accepted. Specifications and general drawings of this plant must be submitted with proposals in accordance with the requirements of paragraph 36.

TENDER NO. 5.

168. *Description.*—Tender No. 5 will be built in all respects similar to Nos. 1, 2, 3, and 4, and in accordance with the foregoing specifications and drawings, except in such particulars as are here noted, namely; the grate bars of boiler will be 3 inches longer; the engines will have cylinders 24 inches in diameter, and the cranks, shaft, pitmans, and other working parts will be made in proportion to cylinders; the wheel will be 24 feet 6 inches in diameter over buckets, and buckets will be 36 inches wide; together with any minor alterations that may be required in consequence of the above changes. Drawings and specifications of the engines proposed will be furnished by the bidder, in accordance with the requirements of paragraph 36.

H. E. WATERMAN,
Captain, Corps of Engineers,
Secretary Mississippi River Commission.

MISSISSIPPI RIVER COMMISSION, OFFICE OF THE SECRETARY,
St. Louis, Mo., Apr. 27, 1898.

APPENDIX 1 O.

REPORT OF MR. J. A. OCKERSON, ASSISTANT ENGINEER, ON THE FIELD AND OFFICE WORK PERTAINING TO SURVEYS, GAUGES, DISCHARGE WORK, REDUCTION OF OBSERVATIONS, AND MAPPING.

ST. LOUIS, MO., *May 15, 1898.*

SIR: I have the honor to submit the following report on the field and office work pertaining to the general survey of the Mississippi River, the low-water survey, Scot Bluff to Carrollton, precise levels, Baton Rouge to end of east jetty at mouth of South Pass, care and repair of gauges, discharge measurements, computation and reduction of field notes, platting and publication of maps and results.

THE GENERAL SURVEY OF THE MISSISSIPPI RIVER FROM THE HEAD OF PASSES TO THE HEAD WATERS.

This work under the Mississippi River Commission has been carried on under the appropriations and allotments for surveys, gauges, and observations. The condition of the work at this date may be summarized as follows:

The secondary triangulation has been completed from the mouth of the river to Minneapolis, Minn., a distance of 1,992 miles. About 400 miles of this work was done by the United States Engineer Corps and the Coast and Geodetic Survey prior to the organization of the Commission.

The precise levels have been completed from the Gulf end of east jetty at mouth of South Pass to St. Paul, Minn., a distance of 1,982 miles, with side lines, Biloxi, Miss., to Carrollton, La., 87 miles; Savanna, Ill., to Chicago, Ill., 148 miles; and St. Paul, Minn., to Duluth, Minn., 156 miles; a grand total of 2,373 miles. That portion of the line lying between Carrollton, La., and Greenville, Miss., a distance of 479 miles, was run for the Commission by parties belonging to the Coast and Geodetic Survey.

The topography and hydrography has been completed from Head of Passes, La., to Minneapolis, Minn., a distance of 1,980 miles. The topography below Cairo, Ill., includes the careful instrumental location of shore lines, sand bars, and all natural and artificial features within a mile or so of the river, with sufficient elevations for accurate location of 5-foot contours. Above Cairo the topography includes also the location of bluffs bordering on the river valley proper.

A map of the lower alluvial valley, Cairo to the Gulf of Mexico, has been compiled, drawn, and published. This map is in 8 sheets and shows the Mississippi

River, its lower tributaries, and the area subject to overflow. A district map showing the river from Cairo to the Gulf, together with controlling levee lines, levee and engineer districts, has been published. Charts showing the topography and hydrography in detail have been published on a scale of 1:20,000, covering the river from Head of Passes to Arnolds Landing, Ill., a distance of 1,651 miles, in 138 sheets. Maps of the river on a scale of 1 inch to 1 mile, showing the river banks, adjacent topography, sand bars, and channel line have been published in 54 sheets, covering the river from Port Eads, La., to Clinton, Iowa, a distance of 1,617 miles. Three of the four sheets of the upper alluvial valley map, which will cover the river from Cairo, Ill., to St. Paul, Minn., have been completed, and the two lower sheets have been printed.

Special surveys have been made between Cairo, Ill., and Carrollton, La., to determine amount and character of changes which occur in the bed and banks of the stream.

A detailed statement of the earlier work done will be found in the report of the Commission for 1896, pages 3575 and 3576.

FIELD WORK OF 1897.

The general survey was resumed near Brownsville, Minn., on May 20, 1897, with the following organization: Asst. Engineer A. T. Morrow in charge; W. G. Comber, George H. French, W. S. Williams, O. N. Axtell, F. G. Ray, M. I. Powers, L. C. Dziatzko, topographers; W. H. Roper and C. G. Weyl, ordinary levels; C. V. Seastone, and D. L. Reaburn, platting. About the last of June the party was increased by the addition of E. J. Thomas, topographer, and F. F. Axtell, platting.

The hydrography was begun the latter part of August, with T. C. Hockridge, master of the steamer *Patrol*, in charge, assisted by C. G. Weyl and L. C. Dziatzko. The first sounding done covered Lake Pepin, and after its completion operations were transferred to St. Paul and continued southward from that point. There was also a regular steamboat crew and laboring force, making a total of about 60 persons in the party, which was quartered on the steamer *Patrol* and survey boat *Illinois*. Owing to the high stage of the river, which made access to the bottom lands difficult, the work was confined to the topography of the high lands, cities, towns, and the ordinary levels until late in August. The shore lines of the river, the topography of the bottoms, and the soundings were taken up at St. Paul on September 3, and continued southward to near Brownsville.

The survey of this season has been unusually tedious, owing to the intricate maze of sloughs which cover the greater part of the area lying between the bluffs.

The work of this season also includes the survey of several cities of considerable size, viz:—St. Paul, Hastings, Prescott, Redwing, Lake City, Winona, and La Crosse; also smaller towns, such as Newport, Diamond Bluff, Trenton, Wacouta, North Pepin, Reads Landing, Wabasha, Alma, Minneiska, Fountain City, Trempealeau, and Brownsville. The area covered in the survey of these cities and towns was 59 square miles.

On November 16 the field work was completed to the upper limits of the work of 1896, and the party was disbanded. The plant and a portion of the crew were transferred to the lower river for use on the low-water survey. The surveyors were transferred to the office in St. Louis to reduce and plat the field notes.

The topographical and hydrographical field work is now completed to the upper limits of Fort Snelling Military Reservation, about 7 miles above steamboat landing at St. Paul. The amount of work done during the field season is given in the following summary:

Miles of main river surveyed (channel distance)	175
Number of square miles of topography	500
Number of square miles of hydrography	84.5
Number of soundings	49,358
Number of sextant angles read to locate soundings	4,458
Number of distances read to locate soundings	8,968
Number of elevations determined by ordinary levels	12,560
Total number of instrumental locations in topography	207,856
Total number of elevations determined in topography	170,612
Average number of instrumental locations per square mile of topography	416
Average number of elevations determined per square mile of topography	341

The discrepancies in the results of precise and ordinary levels are given in the following table:

TABLE NO. 1.—*Discrepancies between the results of precise and ordinary levels.*

Between—	Distance.	Closure.	Ordinary levels run by—
	Miles.	*Feet.*	
P. B. M. 196 and P. B. M. 195	4.2	+0.10	W. H. Roper.
P. B. M. 195 and T. B. M. 162	2.2	+ .16	Do.
T. B. M. 162 and T. B. M. 161	1.1	+ .01	Do.
T. B. M. 161 and P. B. M. 192	3	— .03	Do.
P. B. M. 192 and T. B. M. 158	1.5	— .01	Do.
P. B. M. 188 and P. B. M. 186	3.1	.00	C. G. Weyl.
P. B. M. 186 and P. B. M. 184	.7	.00	Do.
P. B. M. 184 and P. B. M. 183	1.7	— .01	Do.
P. B. M. 183 and P. B. M. 181	2.3	— .09	Do.
P. B. M. 181 and P. B. M. 178	2	+ .03	Do.
P. B. M. 178 and P. B. M. 177	4.1	— .01	Do.
P. B. M. 177 and P. B. M. 174	2.3	.00	Do.
P. B. M. 174 and P. B. M. 172	1.7	+ .05	Do.
P. B. M. 172 and P. B. M. 170	1.7	— .03	Do.
P. B. M. 170 and old U. S. B. M. at water tower	3.6	— .10	Do.
P. B. M. 165 and P. B. M. 163	2.6	+ .01	W. H. Roper.
P. B. M. 163 and P. B. M. 160	2.5	.00	Do.
P. B. M. 160 and P. B. M. 159	1.7	.00	Do.
P. B. M. 159 and P. B. M. 157	1.8	+ .03	Do.
P. B. M. 157 and P. B. M. 156	2.3	+ .02	Do.
P. B. M. 156 and P. B. M. 154	4.4	+ .09	Do.
P. B. M. 154 and P. B. M. 152	4.5	+ .18	Do.
P. B. M. 152 and P. B. M. 150	2.1	+ .05	Do.
P. B. M. 150 and P. B. M. 147	2	— .02	Do.
P. B. M. 142 and P. B. M. 138	3	— .02	C. G. Weyl.
P. B. M. 138 and P. B. M. 135	2.8	— .05	Do.
P. B. M. 135 and P. B. M. 134	2.9	— .09	Do.
P. B. M. 134 and P. B. M. 132	1.2	— .07	Do.
P. B. M. 132 and P. B. M. 131	2.8	— .03	Do.
P. B. M. 131 and P. B. M. 127	3.5	+ .14	Do.
P. B. M. 127 and P. B. M. 124	2.9	— .02	Do.
P. B. M. 124 and P. B. M. 118	5.4	— .04	Do.
P. B. M. 118 and P. B. M. 115	4.8	— .07	Do.
P. B. M. 115 and P. B. M. 113	1.5	+ .02	Do.
P. B. M. 105 and P. B. M. 103	.7	+ .01	W. H. Roper.
P. B. M. 103 and P. B. M. 99	4.6	+ .08	Do.
P. B. M. 99 and P. B. M. 95	2.9	— .01	Do.
P. B. M. 95 and P. B. M. 93	2.4	.00	Do.
P. B. M. 93 and P. B. M. 91	1.6	+ .03	Do.
P. B. M. 91 and P. B. M. 90	2.6	— .06	Do.
P. B. M. 90 and P. B. M. 89	1.4	— .01	Do.
P. B. M. 89 and P. B. M. 86	5	+ .08	Do.
P. B. M. 86 and P. B. M. 79	7	— .03	Do.
P. B. M. 79 and P. B. M. 76	6.6	— .06	C. G. Weyl.

The discrepancies between the two lines of ordinary levels, as shown by connections made at intervals of about 3 miles, are shown in the following table:

TABLE NO. 2.—*Discrepancies between the results of the two ordinary level lines.*

NOTE.—Owing to the high water during early part of season, this stretch of river was gone over twice. During first trip, two level lines were run, and, where possible, connections by river crossings were made and elevations of stone line bench marks determined. During second trip only one line of levels was run, connecting with former lines as follows:

At stone line—	Discrepancy.	At stone line—	Discrepancy.	At stone line—	Discrepancy.
	Foot.		*Foot.*		*Foot.*
263	—0.07	246	—0.02	229	—0.19
262	— .02	245	(*a*)	228	— .04
261	.00	244	(*a*)	227	+ .06
260	+ .01	243	(*b*)	226	+ .01
259	+ .10	242	(*b*)	225	+ .18
258	— .01	241	(*b*)	224	— .02
257	+ .04	240	(*b*)	223	+ .06
256	(*a*)	239	(*b*)	222	+ .05
255	.00	238	(*b*)	221	— .02
254	+ .13	237	+ .01	220	— .01
253	— .03	236	+ .01	219	.00
252	+ .06	235	(*a*)	218	+ .04
251	— .02	234	+ .04	217	+ .01
250	— .02	233	+ .05	216	+ .06
249	+ .05	232	— .02	215	.00
248	.00	231	(*a*)	214	+ .02
247	(*a*)	230	(*a*)		

[a] No connection with former lines.

[b] Lake Pepin.

The elevation of the water surface is determined by Wye levels at frequent intervals on both sides of the river. These elevations furnish the data for surface slope which are given in the following table:

TABLE No. 3.—*Slope of water surface in the Mississippi River between consecutive stone lines from Fort Snelling, Minn., to Brownsville, Minn., June 24 to November 5, 1897.*

No. of stone line.	Location of stone line.	Elevation of water surface above Memphis datum.	Total slope between lines.	Midstream distance between lines.	Slope per mile.
		Feet.	*Feet.*	*Miles.*	*Feet.*
263	½ mile below Soldiers' Home, St. Paul, Minn	702.51	....	....	....
262	3 miles above high bridge at St. Paul, Minn	698.38	4.13	2.9	1.42
261	At high bridge, St. Paul, Minn	696.78	1.60	3.1	.52
260	½ mile below Dayton Bluff	695.54	1.24	3.3	.38
259	At South St. Paul, Minn	693.02	2.52	3	.84
258	At lower end of Newport, Minn	691.42	1.60	3.2	.50
257	At head of Grey Cloud Slough	689.64	1.78	2.9	.61
256	Pine Bend Landing	688.12	1.52	3	.51
255	600 meters above head of Boulanger Slough	686.16	1.96	3	.65
254	At Nininger, Minn	684.14	2.02	3.6	.56
253	½ mile above Hastings, Minn	682.40	1.74	2.8	.62
252	Prescott, Wis	680.63	1.77	3.1	.57
251	3 miles below Prescott, Wis	679.62	1.01	3.1	.33
250	5 miles above Diamond Bluff, Wis	678.87	.75	3.1	.24
249	2 miles above Diamond Bluff, Wis	678.25	.62	2.8	.22
248	1 mile below Diamond Bluff, Wis	676.94	1.31	3.2	.41
247	1 mile above Trenton, Wis	675.98	.96	3.2	.30
246	½ mile above Red Wing, Minn	675.43	.55	3.1	.18
245	½ mile above Reform School	674.93	.50	3.3	.15
244	½ mile below Bay City, Wis	674.67	.26	2.8	.09
243	3 miles above Lakeside Hotel	674.60	.07	3.1	.02
242	At Lakeside Hotel	674.62	—.02	4.4	.00
241	At Florence, Minn	674.66	—.04	3	.00
240	Upper end of Lake City, Minn	674.70	—.04	2.6	.00
239	2½ miles below Lake City, Minn	674.59	.11	3.5	.00
238	At upper end of Pepin, Wis	674.59	.00	2.7	.00
237	1½ miles above Reads Landing, Minn	674.34	.25	2.9	.09
236	½ mile below Island No. 29	672.69	1.65	3.1	.53
235	1½ miles below Wabasha, Minn	670.27	2.42	3.1	.78
234	3 miles above Alma, Wis	667.91	2.36	2.9	.81
233	Alma, Wis	665.71	2.20	3.2	.69
232	3 miles below Alma, Wis	664.07	1.64	2.8	.59
231	3 miles above Minneiska, Minn	662.56	1.51	2.8	.54
230	Head of Island No. 40	660.31	2.25	3.7	.61
229	Head of Island No. 51	658.69	1.62	3	.54
228	3 miles above Fountain City, Wis	657.26	1.43	3.1	.46
227	Lower end of Fountain City, Wis	654.84	2.42	3.3	.73
226	At Wilds Landing	652.65	2.19	3	.73
225	At Winona, Minn	650.37	2.28	3.5	.65
224	1½ miles above Homer, Minn	649.30	1.07	3.3	.32
223	6 miles below Winona, Minn	647.77	1.53	2.9	.53
222	At Lamoille, Minn	645.94	1.83	3.3	.55
221	1½ miles below Trempealeau, Wis	644.54	1.40	2.9	.48
220	600 meters below Queens Bluff	642.57	1.97	2.7	.73
219	Upper end of Dakota, Minn	641.15	1.42	3	.47
218	1½ miles below Dresbach, Minn	639.78	1.37	3.4	.40
217	At River Junction	638.55	1.23	2.7	.46
216	Lower end of La Crosse, Wis	636.86	1.69	3.5	.48
215	Mouth, Root River	635.54	1.32	3.1	.43
214	2 miles above Brownsville, Minn	633.91	1.63	2.9	.56
213	1 mile below Brownsville, Minn	632.33	1.58	3.2	.49

Fall from 243 to 238 in Lake=0.01. Distance=16.2 miles. W. S. is level.

The minus (—) or up-hill slopes are not considered real, but due to probable instrumental errors, and changes in stage due to wind, etc.

A list of all the bench marks of permanent value, high-water marks, gauges, bridges, bases of railroad rails, etc., whose elevations were determined during the season are given in the following tabulation:

TABLE NO. 4.

DESCRIPTIONS OF BENCH MARKS FROM NEAR BROWNSVILLE, MINN., TO ST. PAUL, MINN., WITH ELEVATIONS IN FEET ABOVE THE MEMPHIS DATUM.

[Mean Gulf level at Biloxi, Miss., preliminary value, is 8.13 feet above the Memphis datum. R. B. signifies right bank and L. B. signifies left bank.]

STONE LINE 213 (CROSSES RIVER AT HEAD OF RAFT CHANNEL, 1 MILE BELOW BROWNSVILLE, MINN.).

${}^{2}|^{13}$. Tile and iron pipe planted on left bank opposite head of Island No. 120. B. M. stands by large lone elm, 50 meters from shore. To 16-inch elm, 177° 20′—3.9 meters; to 30-inch elm, 24° 50′—6.7 meters.

Elevation cap on pipe, 638.81. Bolt in tile, 634.85.

${}^{2}|^{13}_{2}$. Tile and iron pipe planted on Island No. 120. In grass on high ground, 75 meters below head of island, and 50 meters back from west shore. To 18-inch elm, 279° 26′—10.3 meters; to 18-inch elm, 60° 26′—8.4 meters.

Elevation cap on pipe, 639.38. Bolt in tile, 635.41.

${}^{2}|^{13}_{3}$. Tile and iron pipe planted on right bank at head of Raft Channel, one-half meter east of west fence along wagon road, on west side of Chicago, Milwaukee and St. Paul Railway, 30 meters below bridge No. 658 K, 6 meters above milepost 12-149, and opposite second telegraph pole below yellow frame house at roadside.

Elevation cap on pipe, 656.21. Bolt in tile, 652.24.

U. S. P. B. M. 198. Is in Stoddard, Wis., on foundation of water tank, on the northeast corner of the northeast pier, being top of copper bolt leaded vertically and marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 652.62.

T. B. M. 172. Is about 3,300 feet above Stoddard, near the upper end of the first tangent above the depot, 853 feet below milepost 143, and 330 feet below the farm crossing, 25 feet east from the Chicago, Burlington and Northern Railroad track on embedded bowlder, being highest point in square, marked "U. □ S." Elevation, 648.11.

T. B. M. 1, R. B. In Brownsville, Minn., is a cross on top face of rock in wall of Diamond Jo stone warehouse. T. B. M. is about 3 feet above ground and near figures 91 cut in wall. Elevation, 642.14.

T. B. M. 2, R. B. Is top corner within square on downstream end of upper abutment of bridge No. 674 K (Chicago, Milwaukee and St. Paul Railway). T. B. M. is 8.5 feet toward river from center of track, 4 feet below top of rails, and 0.5 feet above ground. Elevation, 645.53.

STONE LINE 214 (CROSSES RIVER 2 MILES ABOVE BROWNSVILLE, MINN.).

${}^{2}|^{14}$. Tile and iron pipe planted on ridge between two lakes (or sloughs), 100 meters above their junction. To ${}^{2}|^{14}_{2}$, 98° 05′—760 meters; to 24-inch elm, 19° 00′—7.3 meters; to 30-inch elm, 216° 00′—6.5 meters; to 24-inch white oak, 168° 00′—9 5 meters.

Elevation cap on pipe, 641.15. Bolt in tile, 637.19.

${}^{2}|^{14}_{2}$. Tile and iron pipe planted 400 meters above head of Crosby Slough, back of Island No. 116, and 100 meters above foot, and 10 meters back from bank of slough. To 18-inch cottonwood, 263° 16′—2.5 meters; to 15-inch cottonwood, 9° 46′—14.0 meters.

Elevation cap on pipe, 641.64. Bolt in tile, 637.69.

${}^{2}|^{14}_{3}$. Tile and iron pipe planted on right bank 100 meters above head of Swift Slough, about midway between first dam above and first dam below Swift Slough, and 10 meters from top of bank. To 24-inch elm, 165° 25′—3.3 meters; to 36-inch elm, 226° 55′—7.5 meters; to 20-inch elm, 321° 06′—3.5 meters.

Elevation cap on pipe, 640.13. Bolt in tile, 636.18.

${}^{2}|^{14}_{4}$. Tile and iron pipe planted on the west bank of a large slough, 15 meters above a road crossing, 125 meters below culvert No. 682, and 10 meters east of east right of way fence of Chicago, Milwaukee and St. Paul Railway. To ${}^{2}|^{14}_{3}$, 271° 06′—694.2 meters; to 18-inch cottonwood, 240° (mag.)—4.5 meters; to 18-inch birch, 312° (mag.)—14.2 meters.

Elevation cap on pipe, 643.10. Bolt in tile, 639.16.

U. S. P. B. M. 196. Is 3¾ miles above Stoddard, Wis., on the line of the Chicago, Burlington and Northern Railroad, 870 feet above milepost 140, about one-half mile below Jack Branak's house and saloon, and one-fifth mile above Carl Bay's house, 20 feet below gate to farm crossing on right of way, 2 feet from east fence, being copper bolt in tile 3 feet underground. Elevation, 650.38.

U. S. P. B. M. 197. Is top of cap on iron pipe set over P. B. M. 196. Elevation, 654.36.

STONE LINE 215 (CROSSES RIVER AT MOUTH OF ROOT RIVER).

$^{2}\underset{1}{|}{}^{5}$. Tile and iron pipe planted 5 meters from east bank of lake, 40 meters below lower edge of bunch of heavy timber, and 250 meters above a hay shed. To $^{2}\underset{2}{|}{}^{5}$, 94° 36′—860.9 meters; to 24-inch elm, 158° (mag.)—39.5 meters; to 36-inch elm, 349° (mag.)—42.5 meters.

Elevation cap on pipe, 644.60. Bolt in tile, 640.65.

$^{2}\underset{2}{|}{}^{5}$. Tile and iron pipe planted opposite mouth of Root River on Island No. 112, 50 meters back from river bank in lower edge of heavy timber. To 18-inch elm, 181° 13′—10 meters; to 20-inch elm, 212° 13′—18 meters; to 20-inch elm, 323° 00′—4 meters.

Elevation cap on pipe, 640.97. Bolt in tile, 636.98.

$^{2}\underset{3}{|}{}^{5}$. Tile and iron pipe planted on right bank 30 meters back from shore, and 25 meters below mouth of Root River. To 18-inch maple, 313° 46′—17.5 meters; to 18-inch elm, 52° 45′—15.0 meters.

Elevation cap on pipe, 642.24. Bolt in tile, 638.18.

$^{2}\underset{4}{|}{}^{5}$. Tile and iron pipe planted at edge of heavy timber on east bank of lake, about opposite upper end of lake, and 150 meters below upper end of opening. To $^{2}\underset{3}{|}{}^{5}$, 267° 49′—848.3 meters; to 24-inch cottonwood, 71° (mag.)—4.2 meters; to 36-inch elm, 225° (mag.)—26.0 meters; to 15-inch maple, 338° (mag.)—3.6 meters.

Elevation cap on pipe, 640.44. Bolt in tile, 636.38.

U. S. P. B. M. 194. Is on the line of the Chicago, Burlington and Northern Railroad, 2 miles below the brewery at south end of La Crosse, Wis., on the right of way, at the west wire fence, opposite South Junction depot and 33 feet south of the same, being copper bolt in tile 3 feet underground. Elevation, 656.72.

U. S. P. B. M. 195. Is top of cap on iron pipe set over P. B. M. 194. Elevation, 660.71.

T. B. M. 162. Is in south end of La Crosse, on John Gund's stone brewery, 60 feet south from center of track, 8.4 feet west from east corner, on the sloping water table, being highest point in square, marked "U. □ S." Elevation, 681.29.

T. B. M. 161. Is in La Crosse, one-half mile below the highway bridge over the Mississippi, on southeast corner of First and Market streets, on the brick building of the La Crosse Soap Company, on the First street front, on the south end of a stone doorstep, being highest point in square. Elevation, 667.50.

Base of rail at La Crescent, Minn. (Chicago, Milwaukee and St. Paul Railway). Elevation, 657.72.

STONE LINE 216 (CROSSES RIVER AT LOWER END OF LA CROSSE, WIS., AT HEAD OF LA PLUME ISLAND).

$^{2}\underset{1}{|}{}^{6}$. Tile and iron pipe planted on Eighteenth street, on right of way of Green Bay and Western Railroad, one-half meter west of east fence and 50 meters south of south line of Market street.

Elevation cap on pipe, 677.69. Bolt in tile, 673.75.

$^{2}\underset{2}{|}{}^{6}$. Cross cut in square plug on top of hydrant at northeast corner of Market and Third streets, La Crosse, Wis. Elevation, 676.47.

$^{2}\underset{3}{|}{}^{6}$. Tile and iron pipe planted on right bank, opposite foot of Grant Island, 10 meters back from shore on west side of wagon road. To 36-inch elm, 51° 50′—11.1 meters; to 36-inch elm, 95° 42′—13.5 meters.

Elevation cap on pipe, 647.765. Bolt in tile, 643.78.

$^{2}\underset{4}{|}{}^{6}$. Tile and iron pipe planted in small bunch of willows on edge of large open spot which extends back to bluffs. To $^{2}\underset{3}{|}{}^{6}$, 262° 00′—563.2 meters; to 10-inch willow, 160° (mag.)—6.6 meters; to 10-inch willow, 270° (mag.)—2.0 meters.

Elevation cap on pipe, 639.94. Bolt in tile, 635.99.

U. S. P. B. M. 193. Is in La Crosse, Wis., in the west face of the land pier of the highway bridge across the Mississippi River, 5 feet from its north end and 3.5 feet above ground, being the center of a copper bolt leaded horizontally, marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 651.04.

T. B. M. 160. Is in La Crosse, on the west side of the Chicago, Burlington and Northern Railroad depot, on the Second street side, at south side of second door above south end of main building, being highest point in square, marked "U. □ S." Elevation, 664.62.

La Crosse City B. M. On Front street, is on the west side of Front street, between Main and Pearl streets, on the southeast corner of old building joined to the south side of stone building, on the top surface of water table, 0.7 foot above the lower corner, being highest point in square. Elevation, La Crosse datum, 50.00; Memphis datum, 658.52.

Base of rail at River Junction depot, Minn., Chicago, Milwaukee and St. Paul Railway. Elevation, 653.07.

U. S. P. B. M. 192. Is in La Crosse, Wis., on the United States post-office building, on the northeast corner of Fourth and State streets, at south side of south one of three doors fronting on Fourth street, being door next to tower. A copper bolt leaded vertically in the doorstep, marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 686.68.

T. B. M. 158. Is in North La Crosse, near the entrance to the Chicago, Milwaukee and St. Paul roundhouse, in the water-tank foundation stone, the northwest pier, on beveled edge of the top stone, in broken square, marked "U. □ S." Elevation, 652.94.

U. S. P. B. M. 191. Is in North La Crosse, on the Chicago, Milwaukee and St. Paul Railway bridge No. O, over Black River, in the south side of the east pier, 15 inches from the southwest corner, being top of copper bolt leaded vertically, marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 654.04.

T. B. M. 157. Is in North La Crosse, in west pier of drawbridge No. O, over Black River, in north end of pier, being highest point in square cut in coping stone Elevation, 656.39.

STONE LINE 217 (CROSSES RIVER AT RIVER JUNCTION, MINN., 3 MILES ABOVE LA CROSSE, WIS.).

$\frac{217}{1}$. Tile and iron pipe planted on north bank of slough, at edge of open field among some maple, ash, and willow, 46 meters east of wire fence, on property belonging to Mr. Clark. To $\frac{217}{2}$, 89° 11′—1081.1 meters; to 10-inch birch, 45° (mag.)—10.2 meters; to 10-inch willow, 268° (mag.)—8.0 meters; to 8-inch maple, 225° (mag.)—10.7 meters.

Elevation cap on pipe, 643.97. Bolt in tile, 640.01.

$\frac{217}{2}$. Tile and iron pipe planted on Island No. 101, about 200 meters below a point opposite River Junction, 30 meters back from river bank and 15 meters below a slough with dam across head. To 30-inch elm, 229° 15′—17.0 meters; to 30-inch elm, 291° 15′—31.0 meters.

Elevation cap on pipe, 645.90. Bolt in tile, 641.95.

$\frac{217}{3}$. Tile and iron pipe planted at foot of bluff, one-half meter east of fence at side of wagon road, and directly opposite north end of River Junction depot.

Elevation cap on pipe, 675.20. Bolt in tile, 671.24.

U. S. P. B. M. 190. Is on the east pier of the Chicago, Milwaukee and St. Paul Railway bridge, over the east channel of the Mississippi River above La Crosse, on the downstream side, directly south from center of shoe, 9 inches from the face of stone, being top of copper bolt leaded vertically, marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 660.29.

U. S. P. B. M. 189. Is on the west pier of the Chicago, Milwaukee and St. Paul Railway bridge, above La Crosse, lower side of track, on downstream end of cap stone, being a copper bolt leaded vertically, marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 660.22.

U. S. P. B. M. 187. About 1,320 feet above the depot at River Junction, and 915 feet above head block at lower end of siding, 400 feet below J. A. Selzer's stone house and 95 feet above Mr. Edwards's house, on bluff side of the Chicago, Milwaukee and St. Paul Railway track, 66 feet from center and 48 feet from side track, being copper bolt in tile 3 feet underground. Elevation, 659.82.

U. S. P. B. M. 188. Is top of cap on iron pipe set over P. B. M. 187. Elevation, 663.84.

STONE LINE 218 (CROSSES RIVER AT FOOT OF DRESBACH ISLAND, 1½ MILES BELOW DRESBACH, MINN.).

$\frac{218}{1}$. Tile and iron pipe planted at edge of timber, 20 meters east of east edge of dry lake. To $\frac{218}{2}$, 60° 44′—962.1 meters; to 8-inch maple, 61° (mag.)—9.3 meters; to 12-inch maple, 282½° (mag.)—5.9 meters; to 10-inch maple, 345° (mag.)—14.5 meters.

Elevation cap on pipe, 643.23. Bolt in tile, 639.27.

$\frac{218}{2}$. Tile and iron pipe planted in small timber, opposite foot of Dresbach Island, 30 meters back from left bank, 30 meters above a small slough, and 500 meters above a small house. To 24-inch elm, 164° 00′ (mag.)—17.0 meters; 12-inch ash, 235° 30′ (mag.)—3.8 meters.

Elevation cap on pipe, 647.13. Bolt in tile, 643.16.

$\frac{218}{3}$. Tile and iron pipe planted opposite foot of Dresbach Island, at side of wagon road, one-half meter west of west right-of-way fence of Chicago, Milwaukee and St.

Paul Railway, 90 meters above a wagon road leading up large ravine, 30 meters above edge of timber on side of bluff, 125 meters above a small wagon bridge opposite rock culvert under railroad.

Elevation cap on pipe, 700.51. Bolt in tile, 696.56.

T. B. M. 153. Is at mouth of Dresbach Slough, 1,080 feet above milepost 135, on line of the Chicago, Milwaukee and St. Paul Railway, 12 feet west from center of track on rock, being highest point in square marked "U. □ S." Elevation, 670.37.

U. S. P. B. M. 185. Is about 3,600 feet below Dresbach, Minn., and 2,790 feet below milepost 133, on line of Chicago, Milwaukee and St. Paul Railway, on west side of track, 425 feet below Henry Becker's house, and 280 feet above his limekiln, 63 feet below head block at upper end of siding, at west fence, being copper bolt in tile 3 feet underground. Elevation, 663.35.

U. S. P. B. M. 186. Is top of cap on iron pipe set over P. B. M. 185. Elevation, 667.36.

U. S. P. B. M. 184. Is in Dresbach, Minn., on northwest corner of Second and G streets, on front of R. Remp's brick store on south end of stone doorstep, being top of copper bolt leaded vertically, marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 696.69.

Old U. S. B. M. 131. Is in Dakota, Minn., 270 feet below Chicago, Milwaukee and St. Paul Railway depot, 9 feet west from center of track, on water-tank foundation, at the lower side front pier, on southeast corner of base stone, being highest point in circle. Elevation, 659.81.

Base of rail at Dakota, Minn. (Chicago, Milwaukee and St. Paul Railway). Elevation, 661.23.

STONE LINE 219 (CROSSES RIVER AT UPPER END OF DAKOTA, MINN.).

${}^{2}{}^{1}_{1}{}^{9}$. Tile and iron pipe planted in pasture, 140 meters north of road, 50 meters west of junction of sloughs, and 165 meters north of J. Dolphin's house. To ${}^{2}{}^{1}_{2}{}^{9}$, 57° 40′—787.2 meters; to 10-inch white oak, 185° (mag.)—3.2 meters; to 8-inch white oak, 12° (mag.)—16.0 meters; to 12-inch white oak, 76° (mag.)—18.0 meters.

Elevation cap on pipe, 647.81. Bolt in tile, 643.85.

${}^{2}{}^{1}_{2}{}^{9}$. Tile and iron pipe planted on French Island, 350 meters below head of slough at head of island, in bunch of large trees, 5 meters back from river bank, and near lower end of sand bar. To 18-inch maple, 262° 47′—11.6 meters; to 40-inch oak, 68° 37′—6.9 meters; to 30-inch elm, 155° 17′—6.8 meters.

Elevation cap on pipe, 649.91. Bolt in tile, 645.95.

${}^{2}{}^{1}_{3}{}^{9}$=U. S. P. B. M. 182–183. Tile and iron pipe planted in Dakota, Minn., 656 feet above the Chicago, Milwaukee and St. Paul Railway depot, 430 feet below milepost 131, on the west side of wagon road, 262 feet west from center of track, on line with stone fence in front of Amos Shay's residence, 13 feet above its upper end, and 69 feet from a lone blazed cottonwood, standing on the east side of wagon road.

Elevation cap on pipe, 673.85. Bolt in tile, 669.85.

U. S. P. B. M. 180. Is about 1¼ miles below Richmond, Minn., 790 feet below the line of dike above the head of Island No. 90, and 285 feet above the house of Henry Winters, directly opposite the farm crossing, 40 feet from center of track toward river, also 40 feet back from top of river bank, being copper bolt in tile 3 feet underground. Elevation, 670.01.

U. S. P. B. M. 181. Is top of cap on iron pipe set over P. B. M. 180. Elevation, 674.02.

T. B. M. 146. Is 2¼ miles above Dakota, Minn., just above Island No. 90, 660 feet above Henry Winter's house, on the line of the Chicago, Milwaukee and St. Paul Railway, 12 feet west of center of track, being highest point in square marked "U. □ S." Elevation, 678.29.

T. B. M. 144. Is in front of Queens Bluff, in Richmond, Minn., 640 feet above milepost 127, about at center of siding, 12 feet east of track center, on ledge of rock in small cut, being highest point in square marked "U. □ S." Elevation, 662.86.

STONE LINE 220 (CROSSES RIVER 600 METERS BELOW QUEENS BLUFF, ABOUT 4 MILES BELOW TREMPEALEAU, WIS.).

${}^{2}{}^{2}_{1}{}^{0}$. Tile and iron pipe planted on east bank and in bend of swale, just above an S bend in swale, 240 meters northeast of slough crossing stone line. To ${}^{2}{}^{2}_{2}{}^{0}$, 53° 11′—825.25 meters; to 10-inch birch, 34° 30′ (mag.)—3.5 meters; to 12-inch birch, 343° 00′ (mag.)—13.6 meters; blazed 18-inch oak tree stands south 81° east—64 meters.

Elevation cap on pipe, 647.76. Bolt in tile, 643.79.

${}^{2}{}^{2}_{2}{}^{0}$. Tile and iron pipe planted 25 meters back from left bank of river, 75 meters below the second dam below head of Island No. 89. B. M. is on line with ${}^{2}{}^{2}_{3}{}^{0}$ and a house on right bank. To 24-inch double elm, 118° 49′—7.5 meters; to 24-inch leaning birch, 319° 54′—11.3 meters.

Elevation cap on pipe, 650.96. Bolt in tile, 647.01.

$\frac{220}{3}$. Tile and iron pipe planted on bluff side of Chicago, Milwaukee and St. Paul Railway, one-half meter from fence in front of cultivated field, 40 meters below a blacksmith shop at foot of bluff, 113 meters below milepost 128–12, and about 600 meters below Queens Bluff.

Elevation cap on pipe, 687.17. Bolt in tile, 683.17.

U. S. P. B. M. 178. Is in Richmond, Minn., 1,900 feet below bridge 16, and 615 feet above upper end of siding, 100 feet above the upper end of Jacob Danehower's house, 105 feet below lower end of barn, 47 feet west from center of Chicago, Milwaukee and St. Paul Railway track, being copper bolt in tile set 3 feet underground. Elevation, 662.62.

U. S. P. B. M. 179. Is top of cap on iron pipe set over P. B. M. 178. Elevation, 666.62.

T. B. M. 142. Is about 1 mile above Richmond, Minn., at E. Leach's crossing, just above the upper roadside fence, 15 feet east of center of track, on an embedded bowlder, being highest point in square, marked "U. □ S." Elevation, 677.11.

Base of rail at Richmond, Minn. (Chicago, Milwaukee and St. Paul Railway). Elevation, 662.34.

STONE LINE 221 (CROSSES RIVER ABOUT 1¼ MILES BELOW TREMPEALEAU, WIS.).

$\frac{221}{1}$ = ◬ East Base. Tile and iron pipe on east end of Trempealeau base line, on east side of meadow land, 15 meters west of Third Lake, near its lower end.

Elevation cap on pipe, 651.10. Bolt in tile, 647.12.

$\frac{221}{2}$. Tile and iron pipe planted 20 meters back from left bank of river, 150 meters above a dam across slough, and opposite head of Island No. 87. To 18-inch double elm, 18° 10′—4.6 meters; to 18-inch birch, 54° 10′—10.7 meters; to 10-inch maple, 241° 30′—6.2 meters.

Elevation cap on pipe, 653.61. Bolt in tile, 649.66.

$\frac{221}{3}$. Tile and iron pipe planted opposite head of Island No. 86, 1 meter from right-of-way fence of Chicago, Milwaukee and St. Paul Railway. At upper end of small rock cut, 75 meters below culvert No. 285, and also 75 meters below a whistling post.

Elevation cap on pipe, 679.40. Bolt in tile, 675.43.

STONE LINE 222 (CROSSES RIVER AT LAMOILLE, MINN.).

$\frac{222}{2}$. Tile and iron pipe planted on property belonging to John McCarty, in corner of fence, one-half meter from fence along railroad, 50 meters above a house, and opposite foot of small island.

Elevation cap on pipe, 686.60. Bolt in tile, 682.64.

$\frac{222}{3}$ = U. S. P. B. M. 176–177. Tile and iron pipe at Lamoille, 154 feet above Chicago, Milwaukee and St. Paul Railway depot, at foot of bluff, 50 feet southwest from center of track, 35 feet above the upper end of bridge, and 69 feet below frame house.

Elevation cap on pipe, 665.27. Bolt in tile, 661.29.

T. B. M. 135. Opposite foot of Island No. 77, 4,600 feet above Lamoille, 1,950 feet below center of bridge 32 (Chicago, Milwaukee and St. Paul Railway), 1,666 feet above milepost 122, at upper end of cut, 8 feet northeast from center of track, on an embedded bowlder, being highest point in square marked "U. □ S." Elevation, 663.46.

U. S. P. B. M. 174. 2¾ miles below Homer, Minn., opposite end of closing dike behind Island No. 76, 656 feet below bridge 36 on the Chicago, Milwaukee and St. Paul Railway, at the bluff side fence, and 984 feet below milepost 120, being copper bolt in tile 3 feet underground, about 15 feet above grade of track. Elevation, 676.00.

U. S. P. B. M. 175. Is top of cap on iron pipe set over P. B. M. 174. Elevation, 680.00.

Base of rail at Trempealeau (Chicago, Burlington and Northern Railroad). Elevation, 660.64.

R. R. B. M. at Trempealeau, Wis. Is square cut in southwest corner of southwest foundation stone under water tank, just above depot, marked "B. M. 88.36." Elevation, 661.20.

STONE LINE 223 (6 MILES BELOW BRIDGE AT WINONA, MINN., 400 METERS ABOVE FOOT OF BLACKSMITH SLOUGH).

$\frac{223}{1}$. Tile and iron pipe planted 975.0 meters back from $\frac{223}{2}$ on bank of slough on open ground about midway between two points of small timber. The line between $\frac{223}{2}$ and $\frac{223}{1}$ passes about 50 meters below head of a large lake. B. M. is 290 meters back from lake. Blazed tree: 15-inch ash, 230° (mag.)—24 meters; 15-inch ash, 85° (mag.)—21.5 meters.

Elevation cap on pipe, 652.33. Bolt in tile, 648.35.

$\frac{223}{2}$. Tile and iron pipe planted about 150 meters back from Blacksmith Slough, 125 meters back from railroad track, opposite a point about 300 meters above lower end of Blacksmith Slough; also opposite about center of first curve above lower end of Blacksmith Slough. B. M. stands among three lone elm trees on high ground. Trees blazed facing B. M.

Elevation cap on pipe, 651.74. Bolt in tile, 647.62.

$\frac{222}{3}$. Tile and iron pipe planted on right of way of Chicago, Milwaukee and St. Paul Railway, 1 meter from fence, about 190 meters above lower end of curve, being first curve above Blacksmith Slough, back of diamond board, and 400 meters above foot of Blacksmith Slough, on ground about 10 feet higher than railroad track.

Elevation cap on pipe, 678.26. Bolt in tile, 674.20.

Base of rail at Homer, Minn. (Chicago, Milwaukee and St. Paul Railway). Elevation, 666.04.

T. B. M. 132. Is opposite the foot of Island No. 75, on line of Chicago, Milwaukee and St. Paul Railway, 2,370 feet above milepost 120, 15 feet north from center of track on an embedded rock, being highest point in square marked "U. □ S." Elevation, 665.21.

U. S. P. B. M. 172. Is 2,550 feet below station Homer, on the bluffs side of the Chicago, Milwaukee and St. Paul Railway track, 1 foot east from fence, in front of Wm. Besner's brick house on the hill, opposite lone hickory tree standing on bluff side of wagon road, being copper bolt in tile 3 feet underground. Elevation, 665.10.

U. S. P. B. M. 173. Is top of cap on iron pipe set over P. B. M. 172. Elevation, 669.09.

U. S. P. B. M. 170. Is at Minneopa below Winona, on southwest side of Chicago, Milwaukee and St. Paul Railway track, 82 feet below lower end of bridge over Pine Creek, which is first creek below Winona, in E. A. Goodfellow's front yard, 1¼ feet southwest from fence, being copper bolt in tile 3 feet underground. Elevation, 657.38.

U. S. P. B. M. 171. Is top of cap on iron pipe set over P. B. M. 170. Elevation, 661.37.

STONE LINE 224 (ABOUT 1¼ MILES ABOVE HOMER, MINN., BETWEEN ISLANDS NO. 73 AND NO. 74).

$\frac{224}{1}$. Tile and iron pipe 841.4 meters back of $\frac{224}{2}$, by a lone cottonwood tree 75 meters south of Chicago, Burlington and Quincy Railroad track, between two long trestles and opposite a point about 100 meters above lower trestle. Trees blazed with △ facing B. M.

Elevation cap on pipe, 653.88. Bolt in tile, 649.89.

$\frac{224}{2}$. Tile and iron pipe on left bank, about 150 meters back from bank of river, on north bank of small slough and nearly opposite head of Island No. 74, on clear ground with the exception of small bunches of brush, to 6-inch willow tree blazed facing stone 76° 16′—13.7 meters.

Elevation cap on pipe, 658.69. Bolt in tile, 654.77.

$\frac{224}{3}$. Tile and iron pipe on right bank, on property of E. A. Goodfellow, in corner of fence at intersection of Mr. Goodfellow's west line and north fence along wagon road, about 250 meters back from river and same distance to a point opposite upper end of a large railroad trestle.

Elevation cap on pipe, 671.28. Bolt in tile, 667.31.

U. S. P. B. M. 169. Is in lower Winona, on the Winona and Western Railway and Chicago, Burlington and Northern Railroad bridge, on the upstream end of the first pier from the abutment, on the southwest corner of coping stone, being top of copper bolt, leaded vertically, marked $\overset{\text{U.S.}}{\underset{\text{P.B.M.}}{\odot}}$. Elevation, 670.97.

U. S. P. B. M. 168. Is in Winona, Minn., in the court-house, on the north front of the west window sill, about 1 foot above ground, being top of copper bolt leaded vertically, marked $\overset{\text{U.S.}}{\underset{\text{P.B.M.}}{\odot}}$. Elevation, 673.43.

Old U. S. B. M. Is in Winona, on east face of water tower, on the bottom surface of a deep notch cut in base stone, about 2 feet above ground, being highest point in square, on river side of old line. Elevation, 666.

Winona City B. M. In Winona, Minn., is at entrance to water works standpipe, on west end of bottom step, being marked by a light cross. Elevation Winona datum, 94.06; Memphis datum, 665.24.

New gauge at Winona. Is on the Chicago and Northwestern Railway bridge, on pier at south end of drawbridge, at the lower part of its river face, dressed in the masonry to feet and tenths. Elevation of zero, 647.21.

U. S. P. B. M. 167. Is in Winona, Minn., on the north wing wall of land abutment of the Chicago and Northwestern Railway bridge, on the seventh stone step from the top, 5 inches back from its north face and 7 inches from the west face of the sixth step, being top of copper bolt leaded vertically, marked $\overset{\text{U.S.}}{\underset{\text{P.B.M.}}{\odot}}$. Elevation, 668.89.

U. S. P. B. M. 166. Is at Winona, Minn., on the north end of the Chicago and Northwestern Railway bridge, on west end of first pier south of abutment, 4 feet from north face and 2 feet from end of pier, being top of copper bolt leaded vertically, marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 665.11.

STONE LINE 225 (AT WAGON BRIDGE AT WINONA, MINN.)

$\frac{225}{1}$. Tile and iron pipe in open ground about 75 meters toward river from Chicago, Burlington and Northern Railroad track and 50 meters below river end of wagon bridge. Bridge is first one from railroad track toward Winona and on road which crosses river at Winona, 838.8 meters back of $\frac{225}{2}$. Trees blazed with △ facing B. M. To 15-inch ash, 150° (mag.)—38 meters; to 24-inch maple, 310° (mag.)—21.5 meters.

Elevation cap on pipe, 655.58. Bolt in tile, 651.48.

$\frac{225}{2}$. Tile and iron pipe in willow grove on east side of road, 35 meters from Wisconsin end of Winona wagon bridge, 10 meters from road, 1 meter north of prolongation of south side of stone road house. To southeast corner of said road house, 137° 43′—17.5 meters.

Elevation cap on pipe, 657.88. Bolt in tile, 653.91.

$\frac{225}{3}$. Copper bolt leaded vertically in top of stone wall along river front in Winona, on thirty-first capstone up river from stone steps on Center street, twenty-ninth capstone below Main street, 0.65 meter above lower end of stone and 0.30 meter back from outer face of wall, marked $\overset{\text{U. S.}}{\underset{\text{B. M.}}{\odot}}$. Elevation, 662.22.

$\frac{225}{4}$. Copper bolt leaded vertically in top of stone pier of Chicago, Milwaukee and St. Paul Railway water tank; pier is one of two piers which stand farthest south; copper bolt is in east pier near southwest corner of water tank, situated southeast of Chicago, Milwaukee and St. Paul Railway depot about 50 meters, at Mark and Lafayette streets, Winona, Minn., marked $\overset{\text{U. S.}}{\underset{\text{B. M.}}{\odot}}$. Elevation, 664.57.

U. S. P. B. M. 164. Is on left bank of river, opposite Winona, on the right of way of the Chicago and Northwestern Railway at the east fence, 280 feet north from north end of bridge over Mississippi River, being a copper bolt in tile 3 feet underground. Elevation, 654.57.

U. S. P. B. M. 165. Is top of cap on iron pipe set over P. B. M. 164. Elevation, 658.55.

Base of rail at crossing (Chicago, Burlington and Northern Railroad with Chicago and Northwestern Railway) opposite Winona. Elevation, 666.46.

U. S. P. B. M. 162. Is at head of Island No. 69, on Chicago, Burlington and Northern right of way, at east fence, about 500 feet below overhead cable track running from quarry to river, being copper bolt in tile 3 feet underground. Elevation, 667.31.

U. S. P. B. M. 163. Is top of cap on iron pipe set over P. B. M. 162. Elevation, 671.30.

STONE LINE 226 (AT WILD LANDING, 3 MILES ABOVE WAGON BRIDGE AT WINONA, MINN.).

$\frac{226}{1}$. Tile and iron pipe on left bank outside of right of way of Chicago, Burlington and Northern Railroad, 2 meters from west fence at Wild Landing and opposite a point 30 meters above north wall of Mr. Wild's stone house.

Elevation cap on pipe, 671.10. Bolt in tile, 667.14.

$\frac{226}{2}$. Tile and iron pipe on Island No. 66, 10 meters back from east bank, about 250 meters from a dam which is between Islands No. 66 and No. 65; in bunch of large cottonwood trees; trees blazed with a △ facing B. M. To 30-inch cottonwood 268° 00′—5.3 meters; to 36-inch cottonwood, 290° 00′—8.3 meters; to 36-inch cottonwood, 146° 00′—10.4 meters.

Elevation cap on pipe, 659.80. Bolt in tile, 655.86.

$\frac{226}{3}$. Tile and iron pipe back of Island No. 66, 15 meters back from bank of slough, in grass on high ground, about 250 meters below dam at head of Island No. 66, 382.7 meters back of $\frac{226}{2}$. Blazed trees: to 10-inch elm 280° (mag.)—22.5 meters; to 18-inch cottonwood 265° (mag.)—43.0 meters.

Elevation cap on pipe, 658.92. Bolt in tile, 654.93.

T. B. M. 28, L. B. About 1 mile below U. S. P. B. M. 160 is a square cut in ledge of rock, east side of cut, Chicago, Burlington and Northern Railroad, and about 900 feet above milepost 99, marked "B. M.", and is probably a railroad benchmark. Elevation, 675.91.

U. S. P. B. M. 160. Is 1¼ miles below Eagle street, Fountain City, Wis., 31 feet northeast from milepost 98, below large curve in track, on right of way 1 foot from fence, being copper bolt in tile 3 feet underground. Elevation, 676.21.

U. S. P. B. M. 161. Is top of cap on iron pipe set over P. B. M. 160, about 1 foot above ground. Elevation, 680.16.

STONE LINE 227 (AT LOWER END OF FOUNTAIN CITY, WIS.).

${}^{2}\frac{2}{1}{}^{7}$. Tile and iron pipe on left bank on top of bank of river, 75 meters below lower end of rock wall along railroad track, 10 meters west of center of main track of Chicago, Burlington and Northern Railroad, 25 meters below lower end of curve, about 75 meters above head of small slough, at lower end of Fountain City.

Elevation cap on pipe, 670.51. Bolt in tile, 666.55.

${}^{2}\frac{2}{3}{}^{7}$. Tile and iron pipe on property of William Murr, on Island No. 60, about 75 meters back from river on line of fence east and west, which is Mr. Murr's north line. To 12-inch double elm tree, blazed with △, 90° (mag.)—2 meters.

Elevation cap on pipe, 660.00. Bolt in tile, 656.01.

${}^{2}\frac{2}{4}{}^{7}$. Tile and iron pipe on property of William Murr, near his southwest corner, 1 meter north of east and west fence and 3 meters east of corner of fence, to a lone elm tree which stands in corner of fence, 90° (mag.)—3 meters. To ${}^{2}\frac{2}{1}{}^{7}$, 808.3 meters.

Elevation cap on pipe, 658.74. Bolt in tile, 654.75.

U. S. P. B. M. 159. Is in Fountain City, Wis., east of Eagle street, on south side of Main street, on Charles Niemann's saloon, on upper end of window sill, being top of copper bolt leaded vertically and marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 682.44.

Base of rail at Fountain City, Wis., Chicago, Burlington and Northern Railroad. Elevation, 669.26.

Base of rail at Minnesota City, Minn., Chicago, Milwaukee and St. Paul Railway. Elevation, 682.09.

High water 1880, Fountain City, Wis. Elevation, 667.60.

U. S. P. B. M. 157. About 2 miles above Fountain City, Wis., 330 feet below railroad bridge over Maumandee Creek, on right of way of Chicago, Burlington and Northern Railroad, at east fence, being top of copper bolt in tile 3 feet underground. Elevation, 662.04.

U. S. P. B. M. 158. Is top of cap on iron pipe set over P. B. M. 157. Elevation, 666.04.

STONE LINE 228 (3 MILES ABOVE FOUNTAIN CITY, WIS., AT LOWER END OF ISLAND NO. 55).

${}^{2}\frac{2}{1}{}^{8}$. Tile and iron pipe in high open ground about 25 meters west of a small slough, at lower end of a ridge by a lone ash tree, 856.7 meters back of ${}^{2}\frac{2}{2}{}^{8}$. To ash tree, 25° (mag.)—4.8 meters; blazed facing B. M.

Elevation cap on pipe, 660.22. Bolt in tile, 656.23.

${}^{2}\frac{2}{2}{}^{8}$. Tile and iron pipe on left bank about 40 meters back from shore, 180 meters above a log house which stands on bank of river, 225 meters above slough which puts out from river. House is opposite foot of Island No. 55. Trees blazed with △ facing B. M. To 36-inch elm, 30° 54′—4.8 meters; to 24-inch elm, 140° 54′—14.7 meters; to 30-inch elm, 214° 54′—18.2 meters.

Elevation cap on pipe, 663.25. Bolt in tile, 659.30.

${}^{2}\frac{2}{3}{}^{8}$. Tile and iron pipe on right bank of Island No. 55, 25 meters back from bank, 50 meters below lower end of towhead and 600 meters below head of Island No. 55. In bunch of large willow trees blazed with △ facing B. M. To 36-inch elm, 68° 05′—2.8 meters; to 24-inch elm, 158° 35′—6.8 meters; to 18-inch elm, 294° 05′—11.8 meters.

Elevation cap on pipe, 662.82. Bolt in tile, 658.86.

${}^{2}\frac{2}{4}{}^{8}$. Tile and iron pipe 503.7 meters back of B. M. ${}^{2}\frac{2}{3}{}^{8}$ in timber, about 150 meters back of slough. Trees blazed facing B. M. To 24-inch elm, 235° (mag.)—2.6 meters; to 24-inch maple, 125° (mag.)—5.6 meters.

Elevation cap on pipe, 661.56. Bolt in tile, 657.57.

U. S. P. B. M. 155. Is 4¼ miles above Fountain City, Wis., at the farm residence of Peter Suter, 28 feet above center of railroad viaduct over wagon road, and 25 feet southwest from center of track (Chicago, Burlington and Northern Railroad), being top of copper bolt in tile 3 feet under ground. Elevation, 664.54.

U. S. P. B. M. 156. Is top of cap on iron pipe set over P. B. M. 155. Elevation, 668.53.

STONE LINE 229 (AT HEAD OF ISLAND NO. 51, ONE-HALF MILE ABOVE CHIMNEY ROCK).

${}^{2}\frac{2}{1}{}^{9}$. Tile and iron pipe in partly cleared opening in timber, 453 meters back of B. M. ${}^{2}\frac{2}{2}{}^{9}$, 355 meters back of slough and about 20 meters in front of low marshy ground with slough running through center. Trees blazed with △ facing B. M. To 30-inch elm, 357° 59′—28.2 meters; to 30-inch elm, 42° 04′—13.2 meters.

Elevation cap on pipe, 663.09. Bolt in tile, 659.02.

$\frac{229}{2}$. Tile and iron pipe in large timber, 8 meters from bank, behind center of willow bar above head of Island No. 51, 20 meters in front of large slough. Blazed trees: 15-inch elm, 194° 58′—4.5 meters; 30-inch elm, 300° 13′—6.0 meters.

Elevation cap on pipe, 668.08. Bolt in tile, 664.01.

$\frac{229}{3}$. Tile and iron pipe one-half meter north of south right-of-way fence of Chicago, Milwaukee and St. Paul Railway, about 400 meters above prominent bluff point known as Chimney Rock; on bank of railroad cut, 98 meters below railroad culvert L. 531. A very large detached bowlder lies between B. M. and wagon road.

Elevation cap on pipe, 689.72. Bolt in tile, 685.76.

High water 1881, 1 mile above Minneiska. Elevation, 673.38.

High water 1888, 1 mile above Minneiska. Elevation, 671.48.

T. B. M. 117. Is 6 miles above Fountain City, at northeast corner of August Bensel's wagon house, on base stone, being highest point in square. Elevation, 675.18.

STONE LINE 230 (AT HEAD OF ISLAND NO. 40 AT LOWER END OF MINNEISKA, MINN.).

$\frac{230}{1}$. Tile and iron pipe planted in group of three large trees, 50 meters from north bank and about one-half mile below head of lower island behind Sommerfield's Island. Trees blazed with △ facing B. M. To 15-inch elm, 37° 25′—9 meters; to 15-inch maple, 152° 33′—3 meters; to 15-inch elm, 233° 58′—2.2 meters.

Elevation cap on pipe, 669.22. Bolt in tile, 665.29.

$\frac{230}{2}$. Tile and iron pipe planted in grove of large timber behind center of large willow bar and opposite head of Island No. 40, 30 meters in front of and 120 meters above mouth of small slough. Trees blazed with △ facing B. M. To 24-inch elm, 195° 44′— 7 meters; to 30-inch tree, 303° 09′—8.5 meters; to 6-inch elm, 70° 56′—10.5 meters.

Elevation cap on pipe, 665.45. Bolt in tile, 661.48.

$\frac{230}{3}$. Tile and iron pipe one-half meter inside of Chicago, Milwaukee and St. Paul Railway right of way fence and end of line fence between small garden lots in lower end of Minneiska, Minn., 45 meters above road crossing where bluff wagon road turns back from railroad to enter town, 120 meters above culvert L. 591.

Elevation cap on pipe, 687.99. Bolt in tile, 683.91.

U. S. P. B. M. 153. Is 2,500 feet below depot at Cochrane, at mouth of Rose Valley, at road crossing, on right of way of Chicago, Burlington and Northern Railroad, in corner of fence on east side of track below road, being copper bolt in tile 3 feet under ground. Elevation, 677.03.

U. S. P. B. M. 154. Is top of cap on iron pipe set over P. B. M. 153. Elevation, 681.03.

Base of rail at Cochrane (Chicago, Burlington and Northern Railroad). Elevation, 689.32.

Base of rail at Minneiska, Minn. (Chicago, Milwaukee and St. Paul Railway). Elevation, 674.23.

STONE LINE 231 (3 MILES ABOVE MINNEISKA, MINN., AND ABOUT 300 METERS ABOVE HEAD OF ISLAND NO. 47).

$\frac{231}{1}$. Tile and iron pipe planted on Island No. 46, 7 meters back from bank of Pomme de Terre Slough, about 500 meters above mouth of Buffalo City Slough, 535.9 meters back of $\frac{231}{2}$. Blazed trees with △ facing B. M. To 40-inch elm, 80° (mag.)—17.0 meters; to 24-inch elm, 22° (mag.)—13.8 meters.

Elevation cap on pipe, 669.95. Bolt in tile, 665.92.

$\frac{231}{2}$. Tile and iron pipe on Island No. 46, 30 meters back from shore on high ground, and 50 meters below a log house, about 300 meters above head of Buffalo City Slough. Tree blazed with △ facing stone. To 18-inch elm, 134° 21′—5.7 meters; to 12-inch elm, 65° 51′—5.4 meters.

Elevation cap on pipe, 669.31. Bolt in tile, 665.36.

$\frac{231}{3}$. Tile and iron pipe on right bank 15 meters back from bank and 375 meters above Fishers Island. Trees blazed with △ facing B. M. To 12-inch cottonwood, 77° 02′—2.2 meters; to 15-inch cottonwood, 147° 02′—4.7 meters.

Elevation cap on pipe, 670.02. Bolt in tile, 666.07.

$\frac{231}{4}$. Tile and iron pipe 1,090.5 meters back of B. M. $\frac{231}{3}$, at upper end of grove of large elm trees blazed with △ facing stone. To 24-inch elm, 178° (mag.)—5 meters; to 18-inch elm, 7° (mag.)—8.5 meters; to 24-inch elm, 75° (mag.)—26.6 meters.

Elevation cap on pipe, 667.45. Bolt in tile, 663.50.

U. S. P. B. M. 151. Is about 2¼ miles below Alma sawmill, 1,000 feet below railroad bridge, and 800 feet below milepost 83, at west fence on right of way of Chicago, Burlington and Northern Railroad, 45 feet from center of track, directly opposite the large barn with stone foundation and basement, owned by Mr. Bartsch, and midway between two prominent points of bluff, being copper bolt in tile 3 feet under ground. Elevation, 675.36.

U. S. P. B. M. 152. Is top of cap on iron pipe set over P. B. M. 151. Elevation, 679.35.

STONE LINE 232 (3 MILES BELOW ALMA, WIS.).

$\frac{232}{1}$. Tile and iron pipe back of Island No. 41, on right of way of Chicago, Burlington and Northern Railroad, one-half meter west of east fence, 34 rail-lengths below milepost 349–82 and 14 rail-lengths below bridge 447. About midway between two frame houses which stand about one-half mile apart.

Elevation cap on pipe, 679.56. Bolt in tile, 675.58.

$\frac{232}{2}$. Tile and iron pipe on Island No. 41, 25 meters back from bank of river and about 1¼ miles above foot of island, 50 meters below small slough, also 50 meters below upper end of revetment. Trees blazed with △ facing stone. To 6-inch oak, 270° 15′—5.6 meters; to 9-inch maple, 71° 45′—13.4 meters; to 9-inch basswood, 154° 15′—6.0 meters.

Elevation cap on pipe, 672.13. Bolt in tile, 668.17.

$\frac{232}{3}$. Tile and iron pipe on Island No. 42, 15 meters back from bank of river in group of elms about three-fourths mile above foot of island, in front of open spot. Trees blazed with △ facing B. M. To 30-inch elm, 253° 47′—5.7 meters; to 18-inch elm, 132° 17′—7.9 meters; to 18-inch elm, 179° 17′—12.5 meters.

Elevation cap on pipe, 670.01. Bolt in tile, 666.01.

$\frac{232}{4}$. Tile and iron pipe 20 meters back from West Newton Chute and three-fourths mile above foot of Island No. 42, 150 meters below where sand bluff strikes bank of chute, about 250 meters above a house and 20 meters below dike. Trees blazed with △ facing B. M. To 15-inch birch, 20° 06′—12.5 meters; to 15-inch ash, 70° 06′—19.9 meters; to 24-inch elm, 184° 16′—14.9 meters; to 15-inch hickory, 334° 36′—9.0 meters.

Elevation cap on pipe, 673.37. Bolt in tile, 669.41.

U. S. P. B. M. 149. Is three-fourths mile below Alma sawmill, at east fence on right of way of Chicago, Burlington and Northern Railroad, by milepost No. 81 in front of C. Moser's house, 16 feet below gate for farm crossing, being copper bolt in tile 3 feet under ground. Elevation, 682.80.

U. S. P. B. M. 150. Is top of cap on iron pipe set over P. B. M. 149, about 1 foot above ground. Elevation, 686.78.

Old U. S. B. M. 4. Is in the lower end of Alma, opposite "sawmill and lumber" office, 60 feet above small road bridge, on east side of street, at entrance to F. Lane's residence, being highest point in square cut in stone step. Elevation, 687.10.

STONE LINE 233 (AT LOWER END OF ALMA, WIS., AT HEAD OF ISLAND OPPOSITE LOWER END OF TOWN).

$\frac{233}{2}$. Tile and iron pipe one-half meter west of south line of street, 8 meters west of west line of alley between Main and Second streets. South line of street is Mr. Carl L. Schultz's north line, street has steps from Main to Second street, and is 1½ blocks south of Alma brewery.

Elevation cap on pipe, 711.11. Bolt in tile, 707.15.

$\frac{233}{3}$. Tile and iron pipe on east bank of West Newton Chute opposite lower end of Alma, Wis., 10 meters back from bank and about 200 meters below a small slough which puts out from West Newton Chute; 300 meters below upper end of piling. Line between $\frac{233}{2}$ and $\frac{233}{3}$ hits upper end of island, which is opposite $\frac{233}{2}$. Trees blazed with △ facing B. M. To 18-inch elm, 316° 32′—10.6 meters; to 18-inch maple, 237° 47′—13.4 meters.

Elevation cap on pipe, 675.28. Bolt in tile, 671.30.

$\frac{233}{4}$. Tile and iron pipe on south bank of small slough about 125 meters east of large slough. Trees blazed with △ facing B. M. To 18-inch elm, 223° 23′—6.7 meters; to 24-inch maple, 244° 23′—9.7 meters; to 12-inch oak, 40° 23—4.9 meters.

Elevation cap on pipe, 672.99. Bolt in tile, 669.02.

U. S. P. B. M. 148. Is at Alma, Wis., on east side of Main street, in water table of stone house, formerly known as Commercial Hotel, at south side of entrance, 6 inches below iron column, being top of copper bolt leaded vertically, marked $\overset{\text{U.S.}}{\underset{\text{P.B.M.}}{\odot}}$. Elevation, 694.48.

U. S. P. B. M. 147. Is in upper end of Alma, Wis., on the foundation of the Chicago, Burlington and Northern Railroad water tank, in the south part of the southeast stone base, being top of copper bolt leaded vertically, marked $\overset{\text{U.S.}}{\underset{\text{P.B.M.}}{\odot}}$. Elevation, 681.12.

Base of rail at Alma, Wis. (Chicago, Burlington and Northern Railroad). Elevation, 681.12.

U. S. P. B. M. 145. Is on right bank, 1¼ miles above Alma, Wis., at lower line of dike closing chute behind Island No. 36, 60 feet back from river bank, being top of copper bolt in tile set 3 feet underground. Elevation, 670.97.

U. S. P. B. M. 146. Is top of cap on iron pipe set over P. B. M. 145. Elevation, 674.96.

STONE LINE 234 (3 MILES ABOVE ALMA, WIS.).

$\frac{234}{1}$. Tile and iron pipe on Island No. 35, west bank of Beef Slough, about one-half mile above railroad bridge across Beef River, 30 meters below line of south wall of building which is farthest down slough in a small village, and stands west of railroad track. B. M. is 5 meters back from bank and a large 2-foot elm stands on edge of bank southeast of B. M. Trees blazed as usual. To 24-inch elm, 118° 01′—15 meters.

Elevation cap on pipe, 679.35. Bolt in tile, 675.36.

$\frac{234}{2}$. Tile and iron pipe on Island No. 35, about 80 meters back from bank of river, and three-fourths mile below foot of Grand Encampment Island, on high ground about 450 meters above a house which stands on bank of river. Trees blazed with △ facing B. M. To 18-inch elm, 175° 23′—20 meters; to 15-inch oak, 285° 08′—11.8 meters; to 30-inch elm, 54° 08′—18.3 meters.

Elevation cap on pipe, 676.08. Bolt in tile, 672.11.

$\frac{234}{3}$. Tile and iron pipe on property of Geo. Barton, 23 meters below corner of wire fence, also corner of small timber, 35 meters above barn along wire fence. To Mr. Barton's house, 30° (mag.)—69.0 meters.

Elevation cap on pipe, 705.54. Bolt in tile, 701.52.

$\frac{234}{4}$. Tile and iron pipe on top of and at edge of sand ridge on property of S. Brown, at bend of fence, 10 meters above corner of fence, and 200 meters below large red barn.

Elevation cap on pipe, 709.08. Bolt in tile, 705.23.

T. B. M. 38, L. B. Is about 2 miles above Alma, Wis., on Chicago, Burlington and Northern Railroad bridge over Beef River, being top of southwest corner of coping stone on upper pier. Elevation, 681.41.

T. B. M. 100. Is on right bank, midway between Alma, Wis., and Teepeeota Point, on top of sand bluff directly back from sheer log boom, about 260 feet above E. S. Churchill's house, on west side of road, on an oak tree 7 inches in diameter; spike in root. Elevation, 705.45.

U. S. P. B. M. 143. Is on Teepeeota Point, in the northeast corner of David Pugh's yard, 1½ feet from east fence and 22 feet south from corner of fence, 100 feet from northeast corner of house and 90 feet from river, being copper bolt in tile. Elevation, 680.16.

U. S. P. B. M. 144. Is top of cap on iron pipe set over P. B. M. 143. Elevation, 684.14.

STONE LINE 235 (1½ MILES BELOW WABASHA, MINN.).

$\frac{235}{1}$. Tile and iron pipe in open ground by a 10-inch lone oak tree, 50 meters east of edge of timber. To 10-inch oak tree blazed, 276° 50′—8.6 meters.

Elevation cap on pipe, 675.08. Bolt in tile, 670.97.

$\frac{235}{2}$. Tile and iron pipe on left bank, 20 meters back of revetted bank, on high ground in grass east of a very large elm which stands on edge of bank opposite foot of willow bar. To 36-inch elm, 83° 36′—17.6 meters.

Elevation cap on pipe, 677.21. Bolt in tile, 673.25.

$\frac{235}{3}$ = △⃝ East Base. Tile and iron pipe 3 feet long in low ground covered with small willows and about 500 meters below upper end of willows, 100 meters from right bank of Coats Island Chute, on small rise between two marshes on property of Louis Housweidel, about 1 mile below lower end of Wabasha, Minn.

Elevation cap on pipe, 674.10. Bolt in tile, 671.07.

$\frac{235}{4}$. Tile and iron pipe on top of sand terrace, directly toward river from county farm building, one-half meter east of east fence of graveyard and 1½ meters north of southeast corner of graveyard and about 1 mile below Wabasha, Minn.

Elevation cap on pipe, 707.37. Bolt in tile, 703.40.

Base of rail at Nelson Station, Wis. (Chicago, Burlington and Northern Railroad). Elevation, 687.14.

Base of rail at Wabasha, Minn. (Chicago, Milwaukee and St. Paul Railway). Elevation, 713.90.

U. S. P. B. M. 141. Is in lower part of Wabasha, Minn., in Campbell's Addition, in the northwest corner of E. J. Dugan's lot, 1.2 feet from the west fence and 1.6 feet south from street fence, being copper bolt in tile 3 feet underground. Elevation, 685.52.

U. S. P. B. M. 142. Is top of cap on iron pipe set over P. B. M. 141. Elevation, 689.49.

△⃝ West Base, Wabasha. Is tile and iron pipe in lower part of Wabasha, Minn., at top of bank of river, on River street, 6 meters northeast of fence, and 26 meters northwest of southeast corner of fence around pasture lot belonging to Lucas Kuehn, in section 33, township 111, range 10.

Elevation cap on pipe, 680.42. Bolt in tile, 676.46.

U. S. P. B. M. 140. Is in Wabasha, Minn., on the northwest corner of Pembroke and Main streets, on "The Peoples Bank" near the north post of door of corner entrance, directly under the brick line on south side of south window, in water table, being copper bolt leaded vertically, marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 697.70.

Old U. S. B. M. 62½. Is in Wabasha, Minn., at the elevator, between tracks, on north face of retaining wall and 3 feet above the corner of the wall, on west side of runway under track to elevator, on the front part of top surface of lower corner of stone marked "B. M." Elevation, 684.55.

STONE LINE 236 (ABOUT THREE-FOURTHS MILE ABOVE HEAD OF SLOUGH WHICH RUNS BACK OF WABASHA, MINN., AND ONE-HALF MILE BELOW ISLAND NO. 29).

$\frac{236}{1}$. Tile and iron pipe 844.7 meters back of $\frac{236}{2}$ in timber on bank of small slough. Trees blazed with △ facing B. M. To 18-inch elm, 42° (mag.)—12.8 meters; to 24-inch elm, 125° (mag.)—10.0 meters; to 18-inch elm, 265° (mag.)—4.3 meters.

Elevation cap on pipe, 678.26. Bolt in tile, 674.24.

$\frac{236}{2}$. Tile and iron pipe on left bank at lower end of small patch of willows and at upper end of open grassy spot, one-half mile below head of slough. B. M. is 10 meters back from bank. Blazed tree: 10-inch cottonwood, 110° 48′—20.3 meters.

Elevation cap on pipe, 679.13. Bolt in tile, 675.14.

$\frac{236}{3}$. Tile and iron pipe on top of sand ridge back of towhead about one-half mile below foot of Island No. 29. Twenty-five meters back of bank of sloughs in corner of fence on property of Mr. Azel D. Southworth and about 100 meters above his barn.

Elevation cap on pipe, 716.03. Bolt in tile, 712.01.

$\frac{236}{4}$. Tile and iron pipe west of old north and south fence line which divides property of Pat. Kennedy on the east and Rudy Burkhart on the west. Nine hundred and sixty-one and fifty-eight one-hundredths meters back of $\frac{236}{3}$, at foot of bluffs near lime kiln. One-fourth mile above Chicago, Milwaukee and St. Paul Railway depot at Wabasha, Minn. To lime kiln, 145° 00′—18 meters.

Elevation cap on pipe, 745.36. Bolt in tile, 741.38.

U. S. P. B. M. 138. Is at Reads Landing 60 feet east from the intersection of south fence of Water street with the tangent produced of the pontoon bridge, in the northeast corner of Arthur Dunn's lot, 8 feet south from the front fence and 1.6 feet west of east fence, being copper bolt in tile set 3 feet underground. Elevation, 692.34.

U. S. P. B. M. 139. Is top of cap on iron pipe set over P. B. M. 138. Elevation, 696.33.

Ⓐ Bottom. Tile and iron pipe on low, flat ground, opposite Reads Landing, Minn. 220 meters from left bank of river on property of Mrs. S. F. Richards, 45 meters west of Chicago, Milwaukee and St. Paul Railway trestle to bridge, 205 meters southwest of end of trestle and between trestle and small pond. Elevation cap on pipe, 679.15. Bolt in tile, 675.18.

U. S. P. B. M. 137. Is at Reads Landing, 246 feet below Knapp, Stout & Co.'s warehouse, on south side of Water street, in north door of S. Trautman's store in south end of stone doorstep, being copper bolt leaded vertically, marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 693.19.

STONE LINE 237 (ABOUT 1¼ MILES ABOVE READS LANDING AND NEAR THE FOOT OF LAKE PEPIN).

$\frac{237}{1}$. Tile and iron pipe in small timber 20 meters toward river from large open spot and and 944.0 meters back of $\frac{237}{2}$. Trees blazed with △ facing B. M. To 18-inch leaning birch, 220° (mag.)—14.8 meters; to 15-inch maple, 20° (mag.)—10.7 meters.

Elevation cap on pipe, 678.60. Bolt in tile, 674.54.

$\frac{237}{2}$. Tile and iron pipe on left bank on bank of and 35 meters below head of bay, 200 meters below where river begins to widen out into Lake Pepin, about 50 meters back from bank of river. Tree blazed: 15-inch birch, 294° 19′—3.7 meters.

Elevation cap on pipe, 682.09. Bolt in tile, 678.12.

$\frac{237}{3}$. Tile and iron pipe on right of way of Chicago, Milwaukee and St. Paul Railway, one-half meter from fence and at foot of Lake Pepin, 80 meters above milepost 63-77, 70 meters below a whistling post.

Elevation cap on pipe, 705.30. Bolt in tile, 701.33.

U. S. P. B. M: 135. Is on Lake Pepin 1¼ miles above Reads Landing, at Roscoes Coulee in point of hill between wagon road and railroad, opposite John Sandburn's house, 30 feet south from center of tract, 16 feet east from east bank of creek, and 20 feet north from north side of road bridge, being copper bolt in tile 3 feet underground. Elevation, 692.29.

U. S. P. B. M. 136. Is top of cap on iron pipe set over P. B. M. 135, 1 foot above ground. Elevation, 696.29.

U. S. P. B. M. 133. Is on Lake Pepin, 150 feet below the section house, 50 feet south from center of track, 80 feet below center of bridge, on right of way at south fence, 7 feet east of east gate post of gate across road leading through to Smith's land, being copper bolt in tile. Elevation, 689.97.

U. S. P. B. M. 134. Is top of cap on iron pipe set over P. B. M. 133. Elevation, 693.98.

STONE LINE 238 (AT UPPER END OF PEPIN, WIS.).

$\frac{238}{1}$. Tile and iron pipe one-half meter north of south fence of wagon road, 4 meters west of west line of fence of another wagon road which runs north of first road; first road runs east and west at foot of bluffs. B. M. 1132.3 meters back of $\frac{238}{2}$. Trees blazed as usual. To 18-inch oak, 160° (mag.)—8.1 meters; to 24-inch oak, 250° (mag.)—15.7 meters.

Elevation cap on pipe, 764.75. Bolt in tile, 760.79.

$\frac{238}{2}$. Tile and iron pipe in corner of fence northwert corner Fourth and Locust streets, one-half meter northeast of corner, on property of Orrin G. Fuller, in upper end of town of Pepin, Wis. To blazed ash tree, 130°—18.6 meters.

Elevation cap on pipe, 744.17. Bolt in tile, 740.21.

$\frac{238}{3}$. Tile and iron pipe on property of Fred S. Mouse, one-half meter outside of right of way of Chicago, Milwaukee and St. Paul Railway. Elevation about 20 feet above railroad track, 15 meters upstream from a point opposite station at Kings Coulee. To 10-inch blazed oak, 47° 12′—14.0 meters.

Elevation cap on pipe, 715.59. Bolt in tile, 711.63.

Base of rail at Pepin, Wis. (Chicago, Burlington and Northern Railroad). Elevation, 690.21.

H. W. 1897 at Pepin, on culvert No. 346. Elevation 684.92.

H. W. 1897 at Pepin, on elevator. Elevation, 684.98.

H. W. 1888 at Pepin on elevator. Elevation, 684.23.

◬ Lakeport. Tile and iron pipe on edge of sand terrace at Lakeport, Wis. Station is one-fourth mile below mouth of Deer Lake and 100 meters from shore of Lake Pepin, 10 meters north of right-of-way fence of Chicago, Burlington and Northern Railroad, 21 meters southeast of southeast corner of small frame house belonging to Mrs. N. O. Murray, 6 meters west of small ravine, in section 22, township 23, range 15. To corner of house, 198° 18′—21 meters. Elevation cap on pipe, 719.97. Bolt in tile, 716.01.

U. S. P. B. M. 132. Is on Lake Pepin, at Keplers Coulee, 1¼ miles above Kings Coulee station, at upper end of cut above bridge, on north sloping face of an exceedingly large bowlder, being top of copper bolt leaded vertically, marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 687.93.

STONE LINE 239 (ABOUT 2½ MILES BELOW LAKE CITY, MINN.).

$\frac{239}{1}$. Tile and iron pipe on right of way of Chicago, Burlington and Northern Railroad, 672.3 meters back of $\frac{239}{2}$, one-half meter south of north right-of-way fence, and 58 meters above bridge No. 482, 43 meters above north-and-south fence, being same fence that runs by $\frac{239}{2}$.

Elevation cap on pipe, 687.91. Bolt in tile, 683.95.

$\frac{239}{2}$. Tile and iron pipe on top of left bank of Lake Pepin, one-half meter west of a north-and-south fence, and about 1 mile below where bluffs come out to lake. B. M. is back of a gravel beach. To 24-inch cottonwood, blazed, 332° 23′—15.8 meters.

Elevation cap on pipe, 685.41. Bolt in tile, 681.45.

$\frac{239}{3}$ = ◬ Loon. Tile and iron pipe on rock point between Chicago, Milwaukee and St. Paul Railway and Lake Pepin, 2¼ miles below Government breakwater at Lake City, Minn., and above Kings Coulee, 11 rail lengths from milepost 69–71.

Elevation cap on pipe, 698.40. Bolt in tile, 694.44.

U. S. P. B. M. 130. Is on Lake Pepin, 2 miles below Lake City, Minn., one-half mile above first high bluff, 105 feet below bridge, on Chicago, Milwaukee and St. Paul Railway right of way, at east fence, 115 feet from top of lake bank, at upper end of cut, being copper bolt in tile. Elevation, 699.21.

U. S. P. B. M. 131. Is top of cap on iron pipe set over P. B. M. 130. Elevation, 703.21.

U. S. P. B. M. 129. Is in Lake City, Minn., on the southeast corner of Front and Center streets, on the "Merchants' Bank" building in east end of stone doorstep, being copper bolt leaded vertically, marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 696.88.

U. S. P. B. M. 128. Is in Lake City, Minn., on west side of Front street, between Lyon avenue and Center street, on T. W. Palmer's shoe store in north end of window seat, being top of copper bolt leaded vertically, marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 696.79.

Old U. S. B. M. Is in Lake City, Minn., on Diamond Jo elevator, 10¼ feet west of southeast corner, at west end of stone pier in southeast quarter of old cross, on foundation stone. Elevation, 682.27.

STONE LINE 240 (CROSSES RIVER AT UPPER END OF LAKE CITY, MINN.).

$\frac{240}{2}$. Tile and iron pipe on right of way of Chicago, Burlington and Northern Railroad about 500 meters below depot at Stockholm, Wis., 115 meters below head block of switch, 140 meters above milepost 58–373, 1¼ meters north of south right-of-way fence, 1¼ meters west of fence running to cattle guard. To 12-inch walnut tree, blazed, 310° 32′—9.2 meters.

Elevation cap on pipe, 697.35. Bolt in tile, 693.39.

$\frac{240}{3}$. Tile and iron pipe in upper end of Lake City, Minn., on south side of road leading toward Sugar Loaf, one-half meter from fence and 25 meters back from corner of street, about 150 meters back from bank of lake; road that runs toward Sugar Loaf is about 400 meters below an old mill which stands on bank of lake at point where shore makes a big bend toward Central Point.

Elevation cap on pipe, 718.01. Bolt in tile, 714.04.

$\frac{240}{4}$. Tile and iron pipe 868.65 meters back of $\frac{240}{3}$, on west edge of sand ridge on property of Mr. Charles Goned, 30 meters west of wire fence, also edge of timber. Trees blazed with △ facing B. M. To 10-inch oak, 220° (mag.)—10.9 meters; to 12-inch oak, 10° (mag.)—3.6 meters.

Elevation cap on pipe, 729.52. Bolt in tile, 725.53.

Base of rail at Stockholm, Wis., Chicago, Burlington and Northern Railroad. Elevation, 694.95.

Base of rail at Lake City, Minn., Chicago, Milwaukee and St. Paul Railway. Elevation, 717. 38.

U. S. P. B. M. 126. Is on Lake Pepin, at Central Point, on east boundary line of Front street, 66 feet from fence on west side of street, 150 feet northward from northwest corner of Front and Main streets, 95 feet from southwest corner of sawmill, being copper bolt in tile. Elevation, 682.73.

U. S. P. B. M. 127. Is top of cap on iron pipe set over P. B. M. 126, standing about 8 inches above surface of ground. Elevation, 686.71.

U. S. P. B. M. 124. Is on Lake Pepin, in Florence, Minn., on northwest corner of streets, 134 feet north of corner which is southeast corner of Mr. Johnson's yard, on west side of wagon road, 6 inches back of face line produced of iron fence, being top of copper bolt in tile. Elevation, 686.73.

U. S. P. B. M. 125. Is top of cap on iron pipe set over P. B. M. 124, standing about 1 foot above ground. Elevation, 690.73.

STONE LINE 241 (CROSSES RIVER AT FLORENCE, MINN.).

$\frac{241}{2}$. Tile and iron pipe on right of way of Chicago, Burlington and Northern Railroad, 2 meters from fence directly in front of Maiden Rock; a telegraph pole marked $\frac{45}{16}$ stands 7 meters south of B. M., 110 meters above a post marked 57–58, and 125 meters above a crossing sign.

Elevation cap on pipe, 700.16. Bolt in tile, 696.19.

$\frac{241}{3}$. Tile and iron pipe planted one-half meter north of east-and-west fence on property of T. E. Freeman, in upper part of Florence, Minn. Above fence is Mr. Freeman's south line, about 200 meters north of wagon road that leads from Florence to bluffs and 25 meters back from bank of lake.

Elevation cap on pipe, 684.11. Bolt in tile, 680.14.

$\frac{241}{4}$. Tile and iron pipe on top and near edge of sand ridge, 12 meters east of fence that follows top of sand ridge, 85 meters north of wagon road which runs from Florence toward bluffs.

Elevation cap on pipe, 780.01. Bolt in tile, 776.03.

U. S. P. B. M. 122. Is on Lake Pepin, at Lake Side Hotel, 50 feet southward from driven well on point, 7 feet east of path leading to well, 13 feet east of oak tree, being copper bolt in tile 3 feet under ground. Elevation, 682.01.

U. S. P. B. M. 123. Is top of cap on iron pipe set over P. B. M. 122. Elevation, 686.

T. B. M. 74. Is on Lake Pepin, 1½ miles below Lake Side Hotel, about one-half mile back west of lake shore, at fork of roads in front of convent, 36 feet west from main road and 25 feet south from end of culvert under road leading to convent, on a 2-foot oak tree, being nail in root. Elevation, 708.98.

STONE LINE 242 (CROSSES RIVER ABOUT 1 MILE BELOW MAIDEN ROCK CITY, WIS., AT PINE CREEK).

$\frac{242}{2}$. Tile and iron pipe on left bank at foot of bluff on north side of Pine Creek, on property of Mr. W. M. Hawkinson, about 200 meters above bridge across Pine Creek, along path running from railroad track to Mr. Hawkinson's house and 15 meters back from Chicago, Burlington and Northern Railroad track.

Elevation cap on pipe, 692.30. Bolt in tile, 688.33.

$\frac{242}{3}$. Tile and iron pipe on right bank of Lake Pepin, on edge of bank, about 500 meters above hotel at Frontenac, Minn., about 20 meters below a point opposite an old limekiln, 150 meters above an old foundation of building which stands on bank of lake. To blazed 10-inch ash, 258° 40′—2 meters; to southeast corner of limekiln, 98° 10′—34 meters.

Elevation cap on pipe, 695.18. Bolt in tile, 691.20.

Base of rail at Maiden Rock City, Wis., Chicago, Burlington and Northern Rail road. Elevation, 689.58.

T. B. M. 66. Is on the right bank of Lake Pepin about 3,280 feet below wide, flat, wooded sand point, which is about 3¾ miles above Lake Side 300 feet below an exceedingly large rock, under a 6-inch ash tree blazed, on an embedded bowlder about the middle of beach, being highest point in square, marked "U. □ S." Elevation, 679.37.

U. S. P. B. M. 120. Is on Lake Pepin about 3¾ miles above Lake Side on the wide, flat, wooded point; first point below United States light, about in center of point east and west, 230 feet from the end of the point at medium low stage, 190 feet southeast of northwest shore line, being copper bolt in tile. Elevation, 681.58.

U. S. P. B. M. 121. Is top of cap on iron pipe set over P. B. M. 120. Elevation, 685.58.

STONE LINE 243 (CROSSES RIVER ABOUT 1 MILE ABOVE WARRENTON, WIS.).

$\frac{243}{2}$. Tile and iron pipe on left bank of Lake Pepin on south side of bluff in line with the right-of-way fence of Chicago, Burlington and Northern Railroad and at outside corner of right-of-way fence and fence running toward track, back of a gravel beach, 175 meters below milepost 384-47, and about 1 mile above town of Warrenton, Wis. To 10-inch blazed oak, 187°—3 meters.

Elevation cap on pipe, 706.72. Bolt in tile, 702.74.

$\frac{243}{3}$. Tile and iron pipe about 3 miles above Frontenac, Minn., on right bank of Lake Pepin, on ridge 4 meters back of edge, 50 meters above where rocky shore ends and gravel bar begins, 1 mile below a Government light, and 20 meters from foot of bluff, on property of Lyman Boynton. To 15-inch oak blazed 162° 08′—4.2 meters; to 10-inch basswood blazed 250° 08′—6.3 meters.

Elevation cap on pipe, 721.43. Bolt in tile, 717.39.

U. S. P. B. M. 118. Is at Wacouta, Minn., below Ida Creek, at point of steep sand bluff, close to south side of wire fence, 18 feet above large elm tree, being copper bolt in tile. Elevation, 683.33.

U. S. P. B. M. 119. Is top of cap on iron pipe set over P. B. M. 118. Elevation, 687.33.

STONE LINE 244 (CROSSES RIVER ABOUT ONE-HALF MILE BELOW BAY CITY, WIS.).

$\frac{244}{2}$. Tile and iron pipe about one-half mile below Bay City, Wis., on side of bluff 1¼ meters outside of right of way of Chicago, Burlington and Northern Railroad, directly back of a telegraph pole marked ¼¼; a burnt snag stands 4 meters northwest of B. M., 25 meters above lower end of first curve below Bay City.

Elevation cap on pipe, 714.73. Bolt in tile, 710.75.

$\frac{244}{3}$. Tile and iron pipe on right bank, on side of bluff in timber, about 25 meters back from shore, and about 40 feet above river; B. M. in front of cleared spot on side of bluff opposite upper end of large bowlder which stands about 15 meters back of B. M., 125 meters above upper end of Island No. 28. To 8-inch oak blazed 120° 32′—4.2 meters; to 7-inch linn blazed 36° 32′—5.2 meters.

Elevation cap on pipe, 725.58. Bolt in tile, 721.59.

U. S. P. B. M. 116. Is 1¾ miles above Wacouta, Minn., and 1,722 feet above head of south channel at east foot of round point of bluffs on lower side of creek above fishermen's shanties, 15 feet west from 6-inch ash tree blazed with U. S., 30 feet north from another blazed ash and 20 feet east of blazed oak tree, being copper bolt in tile. Elevation, 683.45.

U. S. P. B. M. 117. Is top of cap on iron pipe set over P. B. M. 116. Elevation, 687.44.

T. B. M. 59. Is on right bank 2⅜ miles below Red Wing, Minn., in front of reform school building, 20 feet from shore, 10 feet southwest of blazed elm tree, on large triangular sandstone, marked "U. □ S." Elevation, 679.37.

STONE LINE 245 (CROSSES RIVER ABOUT ONE-HALF MILE ABOVE REFORM SCHOOL, 2 MILES BELOW RED WING, MINN.).

$\frac{245}{1}$. Tile and iron pipe on property of L. P. Johnson, about 100 meters below his house and opposite head of Goose Bay, one-half meter east from a north-and-south fence, and 4 meters back from edge of sand ridge.

Elevation cap on pipe, 768.18. Bolt in tile, 764.21.

$\frac{245}{2}$. Tile and iron pipe on Island No. 24, and opposite foot of Island No. 25, 20 meters back from bank, 100 meters below where a small slough with revetted banks connects river and lower lake. To 15-inch maple, 48° 18′—2.6 meters; to 8-inch elder, 189° 33′—4.6 meters; to 18-inch double cottonwood, 354° 03′—8.2 meters.

Elevation cap on pipe, 683.24. Bolt in tile, 679.27.

$\frac{245}{3}$ = P. B. M. 114–115. Tile and iron pipe about 2 miles below Red Wing, Minn., at a wagon road crossing railroad track, 1¼ meters below east road fence, and 6.1 meters north of center of track and about one-fourth mile above slaughterhouse.

Elevation cap on pipe, 708.24. Bolt in tile, 704.25.

Base of rail at Bay City, Wis., Chicago, Burlington, and Northern Railroad. Elevation, 696.65.

Base of rail at Hager, Wis., Chicago, Burlington, and Northern Railroad. Elevation, 716.00.

Base of rail at Red Wing, Minn., Chicago, Milwaukee and St. Paul Railway. Elevation, 689.90.

[illegible]. Lower Base. Is tile and iron pipe on sand ridge 1¾ miles below town of Hager, Wis., 200 meters below foot of Upper Lake, 50 meters north of Chicago, Burlington, and Northern Railroad track and 25 meters west of small ravine, on property of Leonard Eaton, in section 1, township 25, range 18, Pierce County, Wis.

Elevation cap on pipe, 772.88. Bolt in tile, 768.91.

U. S. P. B. M. 113. Is in Red Wing, Minn., about 1,300 feet below Chicago, Milwaukee and St. Paul Railway depot, at the base and upper end of Barn Bluff, on lower abutment, river side, of small railroad bridge on first step below the top, 6 inches from first step, being top of copper bolt leaded vertically and marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 684.57.

U. S. P. B. M. 112. Is in Red Wing, Minn., on the southwest corner of Plum and Levee streets, in northeast corner of the La Grange Mill, in the east face of the foundation wall, 2.3 feet south from north face and 2.1 feet above sidewalk, being center mark in copper bolt leaded horizontally, marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 695.02.

U. S. P. B. M. Is on Island No. 24, opposite Red Wing, Minn., in front part of Mr. Truttman's yard, 12 feet back from front angle of retaining wall, 10 feet northwest from large cottonwood tree, 3.7 feet eastward from 12-inch maple, 21 feet from southwest corner of Mr. Truttman's house, being top of copper bolt in tile. Elevation, 680.62.

U. S. P. B. M. 111. Is top of cap on iron pipe set over P. B. M. 110, standing about 1 foot above ground. Elevation, 684.59.

STONE LINE 246 (CROSSES RIVER ABOUT 1½ MILES ABOVE RED WING, MINN.).

$\frac{246}{1}$. Tile and iron pipe 467.0 meters back from $\frac{246}{2}$, in timber 30 meters from edge of bank of Upper Lake. To 10-inch elm, blazed, 100° (mag.)—1.5 meters; to 10-inch elm, blazed, 270° (mag.)—2.5 meters; to 12-inch maple, blazed, 190° (mag.)—5.5 meters.

Elevation cap on pipe, 681.50. Bolt in tile, 677.50.

$\frac{246}{2}$. Tile and iron pipe on Island No. 24, 1½ miles above Red Wing, Minn., in grassy spot 20 meters back from bank of river and 175 meters above a small running slough, which connects river and upper end of Upper Lake; bank revetted in front of B. M. To 15-inch cottonwood, blazed, 59° 06′—15.2 meters; to 24-inch cottonwood, blazed, 181° 06′—4.6 meters.

Elevation cap on pipe, 685.84. Bolt in tile, 681.89.

$\frac{246}{3}$. Tile and iron pipe in timber on right bank, 40 meters back from bank of river and three-fourths mile below mouth of Cannon River, about 150 meters above a point opposite head of small slough which connects river with Upper Lake; near a 4-foot elm, the largest tree in the vicinity. To 48-inch elm, blazed, 126° 01′—7.9 meters; to 10-inch ash, blazed, 264° 01′—4.5 meters; to 12-inch maple, blazed, 1° 46′—3.8 meters.

Elevation cap on pipe, 682.22. Bolt in tile, 678.25.

$\frac{246}{4}$. Is tile and iron pipe 1,030 meters back of $\frac{246}{3}$ on left bank of slough which joins Hay Creek through a lake about 400 meters above mouth of Hay Creek. B. M. is 30 meters south of an abrupt turn to east in slough, large maple across slough on point.

Elevation cap on pipe, 681.92. Bolt in tile, 677.95.

U. S. P. B. M. 108. Is 2 miles above Red Wing, Minn., at center of head of Island 24, on highest ground, about 125 feet from left bank of river and 100 feet from chute, being top of copper bolt in tile. Elevation, 681.16.

U. S. P. B. M. 109. Is top of cap on iron pipe set over P. B. M. 108. Elevation, 685.15.

U. S. P. B. M. 106. Is at Trenton Landing, Wisconsin, at foot of sand terrace, about 100 feet below road leading up onto sand terrace, 3 feet from blazed elm tree. Elevation, 681.67.

U. S. P. B. M. 107. Is top of cap on iron pipe set over P. B. M. 106. Elevation, 685.69.

Ⓐ Trenton. Is tile and iron pipe on edge of sand terrace, at Trenton, Wis., 3 miles above Red Wing, Minn., 75 meters from river, 150 meters below mouth of Trenton Slough; in section 23, range 18, township 25, Pierce County, Wis.

Elevation cap on pipe, 772.43. Bolt in tile, 768.47.

STONE LINE 247 (ABOUT 1 MILE ABOVE TRENTON, WIS., AND AT HEAD OF ISLAND NO. 23).

$\frac{247}{1}$. Tile and iron pipe on top and edge of sand ridge by wire fence on property of R. Johnson. About 150 meters up river from a wagon bridge and 50 meters below where small slough strikes sand bluff and runs along foot of same. B. M. surrounded by black-oak trees. To 18-inch oak, blazed, 291° 28′—15.6 meters.

Elevation cap on pipe, 766.51. Bolt in tile, 762.52.

$\frac{247}{2}$. Tile and iron pipe on left bank and 15 meters back from bank of chute. About 75 meters below a point opposite head of an island opposite Island No. 23. About 1 mile above Trenton, Wis., and 150 meters above mouth of small slough. To 12-inch ash, blazed, 168° 08′—5.1 meters; to 10-inch oak, blazed, 300° 53′—7.9 meters.

Elevation cap on pipe, 683.26. Bolt in tile, 679.26.

$\frac{247}{3}$. Tile and iron pipe on property of Thomas Colleshan, and about 100 meters up river from his house, about 40 meters back from bank of river, and at edge of cultivated field, by fence. To 15-inch ash, blazed, 47° 51′—14.6 meters; to 10-inch ash, blazed, 96° 21′—2.8 meters.

Elevation cap on pipe, 681.54. Bolt in tile, 677.54.

$\frac{247}{4}$. Tile and iron pipe in ash timber which averages about 5 inches in diameter. In first bunch of ash timber in line from river, 561.0 meters back of $\frac{247}{3}$. To 12-inch ash, blazed, 40° (mag.)—7.4 meters; to 6-inch ash, blazed, 90° (mag.)—2.0 meters; to 6-inch ash, blazed, 220° (mag.)—5.3 meters.

Elevation cap on pipe, 681.20. Bolt in tile, 677.12.

T. B. M. 84, L. B. Is on left bank about one-third mile above B. M. $\frac{247}{2}$, is top of stone monument dressed to 8 inches square at top, 2 meters back from bank of river, and probably an old U. S. B. M. Elevation, 682.51.

U. S. P. B. M. 104. Is three-fourths mile below Diamond Bluff, Wis., 29 meters south of center of track and 90 meters below east end of bridge over Dry Run, 2 meters northward from blazed post in wire fence, at foot of bank in borrow pit, being copper bolt in tile. Elevation, 727.33.

U. S. P. B. M. 105. Is top of cap on iron pipe set over P. B. M. 104. Elevation, 731.34.

STONE LINE 248 (ABOUT 1 MILE BELOW DIAMOND BLUFF, WIS., AND 500 METERS ABOVE MOUTH OF TRIM BELLE RIVER).

$\frac{248}{1}$ = Ⓐ Mero. Tile and iron pipe at west end of sand terrace on large mound and about one-fourth mile below Trim Belle River and about 1 mile below Diamond Bluff, Wis., one-half mile from bluffs, on property of Mr. Gus Mero.

Elevation cap on pipe, 762.58. Bolt in tile, 758.61.

$\frac{248}{2}$. Tile and iron pipe on left bank about 600 meters above mouth of Trim Belle River, 1 mile below Diamond Bluff, Wis., and about 30 meters back from bank of river. Bank revetted in front of B. M. Three elm trees stand on slope of revetted bank just below B. M., which is about 20 meters above upper tree and 75 meters above fence. To 15-inch elm, blazed, 307° 31′—5.2 meters; to 30-inch elm, blazed, 49° 31′—13.4 meters.

Elevation cap on pipe, 684.68. Bolt in tile, 680.70.

$\frac{248}{3}$. Tile and iron pipe on right bank, 15 meters back from bank of river and opposite a point 600 meters above Trim Belle River, at upper end of thick timber and in a bunch of elm trees about 500 meters below a dam; small willows and cottonwoods in front of B. M. To 15-inch elm, blazed, 51° 01′—6.0 meters; to 24-inch elm, blazed, 83° 31′—10.5 meters.

Elevation cap on pipe, 684.76. Bolt in tile, 680.77.

$\frac{248}{4}$. Tile and iron pipe 468.4 meters back of $\frac{248}{3}$, in small maples; a 30-inch elm, also group of ash trees stand near B. M. To 10-inch ash, blazed, 330° (mag.)—11.0 meters; to 30-inch elm, blazed, 135° (mag.)—20.5 meters.

Elevation cap on pipe, 681.86. Bolt in tile, 677.89.

U. S. P. B. M. 102. Is in Diamond Bluff, Wis., 70 meters east of the Chicago, Burlington and Northern Railroad depot, 14 meters south of track and 2 meters north of wire fence, being top of bolt in tile. Elevation, 729.48.

U. S. P. B. M. 103. Is top of cap on iron pipe set over P. B. M. 102. Elevation, 733.47.

U. S. P. B. M. 100. Is three-fourths mile above Diamond Bluff, Wis., on land of Ed. Colter, on point of bank, about 600 feet below Wind or Spring Creek, 60 feet south of small road bridge and 21 feet nearer the river, being copper bolt in tile. Elevation, 691.06.

U. S. P. B. M. 101. Is top of cap on iron pipe set over P. B. M. 100. Elevation, 695.05.

T. B. M. 83, R. B. Is about 1 mile above Diamond Bluff, Wis., 80 meters above upper wing dam on right bank, 20 meters back from river bank, being wire nail in root of 16-inch cottonwood tree. Elevation, 684.81.

STONE LINE 249 (ABOUT 2¼ MILES ABOVE DIAMOND BLUFF, WIS.).

$^{2}\frac{4}{1}{}^{9}$. Tile and iron pipe on left bank in timber, 20 meters back from bank of river, about 2¼ miles above town, 230 meters below Government light, and 500 meters below a small slough which runs to bluffs 400 meters below Ⓐ Diamond. To 24-inch elm, blazed, 95° 29′—9.4 meters; to 60-inch cottonwood, blazed, 241° 59′—9.7 meters; to 15-inch elm, blazed, 303° 59′—6.6 meters.

Elevation cap on pipe, 685.91. Bolt in tile, 681.95.

$^{2}\frac{4}{2}{}^{9}$. Tile and iron pipe on right bank and on west bank of slough, 30 meters south of wire fence which crosses slough, about 125 meters back from river. Small willows stand in front of B. M. opposite a point about 125 meters up from foot of small willows. To 12-inch ash, blazed, 322° 11′—7.0 meters; to 18-inch elm, blazed, 121° 11′—3.3 meters; to 15-inch ash, blazed, 166° 41′—3.3 meters.

Elevation cap on pipe, 685.36. Bolt in tile, 681.37.

$^{2}\frac{4}{3}{}^{9}$. Tile and iron pipe 428.8 meters back from $^{2}\frac{4}{2}{}^{9}$, 8 meters west of a wire fence and in timber about 75 meters from edge. To 15-inch maple, blazed, 00° (mag.)—6.0 meters; to 10-inch elm, blazed, 230° (mag.)—4.0 meters.

Elevation cap on pipe, 683.42. Bolt in tile, 679.45.

U. S. P. B. M. 98. Is at Smiths Landing, about 10 feet above lower end of bridge and 105 feet eastward from track, 20 feet south from center of creek bed, and 150 feet from southeast corner of Smith's house, under plum tree, being top of copper bolt in tile. Elevation, 687.78.

U. S. P. B. M. 99. Is top of cap on iron pipe set over P. B. M. 98. Elevation 691.78.

STONE LINE 250 (ABOUT 5 MILES ABOVE DIAMOND BLUFF, WIS., AND 300 METERS ABOVE BIG RIVER).

$^{2}\frac{5}{1}{}^{0}$. Tile and iron pipe on right of way of Chicago, Burlington and Northern Railroad, one-half meter from fence and 300 meters above railroad bridge across Big River, 55 meters above a telegraph post [illegible]. Elevation of B. M. about 15 feet above track. To 8-inch oak tree, blazed, 352° 09′—7.0 meters.

Elevation cap on pipe, 711.91. Bolt in tile, 707.95.

$^{2}\frac{5}{2}{}^{0}$. Tile and iron pipe on right bank about 40 meters back from bank of river, back of small willows, and 150 meters above upper end of revetment, which is also lower end of small willows, near a 6-foot cottonwood tree, the largest tree in vicinity. To 72-inch cottonwood, blazed, 244° 02′—8.6 meters; to 18-inch elm, blazed, 88° 02′—4.1 meters.

Elevation cap on pipe, 689.09. Bolt in tile, 685.14.

$^{2}\frac{5}{3}{}^{0}$. Tile and iron pipe 610.2 meters back of $^{2}\frac{5}{2}{}^{0}$, by fence between prairie and timber at edge of timber. To 30-inch elm, blazed, 285° (mag.)—18.5 meters; to 8-inch ash, blazed, 145° (mag.)—15.9 meters.

Elevation cap on pipe, 685.02. Bolt in tile, 681.04.

U. S. P. B. M. 94. Is about 3¾ miles below Prescott, Wis., 43 feet south of Chicago, Burlington and Northern Railroad culvert (now covered up) and 46 feet east of track, being top of copper bolt in tile. Elevation, 686.85.

U. S. P. B. M. 95. Is top of cap on iron pipe set over P. B. M. 94. Elevation, 690.85.

STONE LINE 251 (3 MILES BELOW PRESCOTT, WIS., AT HEAD OF ISLAND NO. 20).

$^{2}\frac{5}{1}{}^{1}$. Tile and iron pipe 1¼ meters north of north right-of-way fence of Chicago, Burlington and Northern Railroad, on sand ridge on property of Edward Scharr, 250 meters below a trestle over a creek and opposite head of Island No. 20. To 6-inch oak, blazed, 167° 25′—11.8 meters; to 10-inch oak, blazed, 226° 10′—19 meters.

Elevation cap on pipe, 723.80. Bolt in tile, 719.83.

$^{2}\frac{5}{2}{}^{1}$. Tile and iron pipe on right bank 40 meters back from river bank by a fence and opposite head of slough which empties into Vermillion River, on property of G. K. Bye. To yellow frame house 330°—20 meters; to 24-inch elm, blazed, 229° 14′—16.8 meters.

Elevation cap on pipe, 691.52. Bolt in tile, 687.55.

$^{2}\frac{5}{3}{}^{1}$. Tile and iron pipe on property of Edward Morris, 50 meters in front of edge of timber, and one-half meter east of north-and-south fence, 133 meters south of corner of fence. A large elm stands west of B. M. To 36-inch elm, blazed, 83° 18′—20.4 meters; to 18-inch elm, blazed, 3° 18′—28.8 meters.

Elevation cap on pipe, 686.12. Bolt in tile, 682.15.

U. S. P. B. M. 92. About 1¾ miles below the bridge across St. Croix River at Prescott, Wis., 125 meters below Chicago, Burlington and Northern Railroad bridge across Pine Coulee, 40 feet below milepost 24, 5 feet west of east right-of-way fence, being top of copper bolt in tile. Elevation, 694.28.

U. S. P. B. M. 93. Is top of cap on iron pipe set over P. B. M. 92. Elevation, 698.27.

U. S. P. B. M. 91. Is at Prescott, Wis., on the east pier of the Chicago, Burlington and Northern Railroad bridge across the St. Croix River, on the north end of bridge seat, being copper bolt leaded vertically, marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 702.10.

STONE LINE 252 (CROSSES RIVER AT BRIDGE OVER ST. CROIX RIVER AT PRESCOTT, WIS.).

$\frac{252}{2}$. Tile and iron pipe 25.9 meters east of Prescott end of Chicago, Burlington and Northern Railroad bridge, 10 meters toward river from first street running parallel to river and 10 meters downstream from line of bridge, elevation 10 feet lower than railroad track. To southeast corner of bridge 108° 51′—25.9 meters.

Elevation cap on pipe, 694.39. Bolt in tile, 690.42.

$\frac{252}{3}$. Tile and iron pipe on right bank about 40 meters back from bank of chute and 150 meters below head of Prescott Island, in small pasture one-half meter east of wire fence. On property of Ernest Beranek and 125 meters below his house. To 12-inch willow, blazed, 177° 19′—4.7 meters.

Elevation cap on pipe, 691.52. Bolt in tile, 687.55.

$\frac{252}{4}$. Tile and iron pipe in pasture on terrace, about 50 meters back from edge and 210 meters south of a wagon road which runs west from river, 1 meter east from a north-and-south wire fence. To 10-inch elm, blazed, 299° 03′—12.3 meters; to 9-inch hackberry, blazed, 337° 18′—16.4 meters.

Elevation cap on pipe, 704.74. Bolt in tile, 700.77.

U. S. P. B. M. 90. Is about 1 mile above bridge over St. Croix River, 60 meters above upper end of small bridge, and 27 meters above E. H. Whittaker's house, on the east side of track, in face of rock cut, being center of copper bolt leaded horizontally, marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 719.30.

U. S. P. B. M. 97. Is at Hastings, Minn., on the drawpier of the Chicago, Milwaukee and St. Paul Railway bridge on upstream side top of masonry, 6 inches south of gangway leading from draw pier to upper breakwater crib. Elevation, 701.80.

U. S. P. B. M. 96. Is opposite Hastings, Minn., on Chicago, Milwaukee and St. Paul Railway, 935 feet up track from drawpier of the Hastings bridge, at bridge over slough, on east end of north abutment, at south part of curve of coping stone, being highest point in square marked U. S. Elevation, 698.13.

High water 1870 at Hastings, Minn. Elevation, 696.44.
High water 1880 at Hastings, Minn. Elevation, 694.41.
High water 1897 at Hastings, Minn. Elevation, 694.63.

STONE LINE 253 (ONE-HALF MILE ABOVE NORTH APPROACH OF WAGON BRIDGE AT HASTINGS, MINN.).

$\frac{253}{2}$. Tile and iron pipe 1 meter south of south right-of-way fence of Chicago, Milwaukee and St. Paul Railway, about one-half mile above north approach of wagon bridge at Hastings, Minn., 200 meters below railroad crossing of Chicago, Milwaukee and St. Paul Railway, and Chicago, Burlington and Northern Railroad, and 125 meters above a wagon-road crossing. To 10-inch box-elder, blazed, 330° 42′—41.1 meters.

Elevation cap on pipe, 696.35. Bolt in tile, 692.40.

$\frac{253}{3}$. Tile and iron pipe on right bank in open ground 20 meters back from bank of river; a well-preserved 18-inch elm stump stands in line with $\frac{253}{2}$ and $\frac{253}{3}$, about 5 meters back from bank of river, above a wire fence and upper end of cultivated field, 150 meters below small clump of willows on bank. To 18-inch elm stump, 227° 15′—15.4 meters.

Elevation cap on pipe 690.07. Bolt in tile, 686.09.

$\frac{253}{4}$. Tile and iron pipe on north side of bluff and 1 meter south of wire fence and 15 meters back from slough, 200 meters above wagon bridge crossing slough, 8 meters down river from line of fence prolonged and three-fourths mile above wagon bridge at Hastings, Minn. To 10-inch oak, blazed, 344° 48′—1.5 meters; to 10-inch oak, blazed, 117° 18′—9.3 meters.

Elevation cap on pipe, 706.48. Bolt in tile, 702.51.

U. S. P. B. M. 88. Is opposite Hastings, Minn., on the line of the Chicago, Burlington and Northern Railroad, 110 feet eastward from center of track and 170 feet south from its crossing with Stillwater branch of Chicago, Milwaukee and St. Paul Railway, just west of wire fence and north of gate, being top of copper bolt in tile. Elevation, 698.69.

U. S. P. B. M. 89. Is top of cap on iron pipe set over P. B. M. 88. Elevation, 702.70.

Old U. S. B. M. 36. Is at foot of Niuinger Slough, about 60 feet from river bank between culverts, 250 feet below upper and 450 feet above lower culvert, on a 14-inch elm tree, being spike in north root. Elevation, 689.58.

STONE LINE 254 (AT NININGER, MINN.).

$\frac{254}{1}$. Tile and iron pipe on Island No. 18, 6 meters from bank of Nininger Slough, at lower end of large maples, 846.9 meters back from $\frac{254}{2}$. To 6-inch maple, blazed, 50° (mag.)—7.8 meters; to 15-inch maple, blazed, 100° (mag.)—13.8 meters.

Elevation cap on pipe, 690.85. Bolt in tile, 686.89.

$\frac{254}{2}$. Tile and iron pipe on Island No. 18, 40 meters back from bank of river on high ground, and 20 meters upstream from dam; dam is opposite and almost in line with wagon road that runs from river up through Nininger, Minn. To 12-inch elm, blazed, 347° 11′—14.5 meters.

Elevation cap on pipe, 691.58. Bolt in tile, 687.61.

$\frac{254}{3}$. Tile and iron pipe at foot of bluff on right bank, 12 meters upstream from west line of road, which runs from river up through Nininger, Minn., 10 meters downstream from a cave in perpendicular cliff. To 4-inch elm, blazed, 320° (mag.)—3 meters.

Elevation cap on pipe, 698.77. Bolt in tile, 694.80.

U. S. P. B. M. 85. Is opposite head of Nininger Slough, 1¼ feet north of south right-of-way fence Chicago, Burlington and Northern Railroad, being top of copper bolt in tile. Elevation, 700.97.

U. S. P. B. M. 86. Is top of cap on iron pipe set over P. B. M. 85. Elevation, 704.98.

STONE LINE 255 (600 METERS ABOVE HEAD OF BOULANGER SLOUGH).

$\frac{255}{1}$. Tile and iron pipe by an east and west wire fence on property of John Benson; east and west fence is Mr. Benson's south line and also section-line fence. B. M. is in cultivated field. To southwest corner of section 32, township 27, range 21, 90°—463.3 meters.

Elevation cap on pipe, 707.51. Bolt in tile, 703.54.

$\frac{255}{2}$. Tile and iron pipe on left bank 10 meters back from bank, in open ground 100 meters above timber and 100 meters below clump of large elms, 8 meters below line of dike. To 24-inch elm, blazed, 37° 17′—10.5 meters.

Elevation cap on pipe, 695.23. Bolt in tile, 691.26.

$\frac{255}{3}$. Tile and iron pipe in heavy elm and maple timber, 37 meters from right bank of river, about 600 meters above head of Boulanger Slough and opposite upper end of timber on left bank, on narrow ridge running parallel with river. To 24-inch elm, blazed, 173° 01′—6.8 meters; to 15-inch maple, blazed, 275° 26′—7 meters.

Elevation cap on pipe, 693.50. Bolt in tile, 689.51.

$\frac{255}{4}$. Tile and iron pipe 2 feet above ground in low swampy land 526.6 meters back from $\frac{255}{3}$, 230 meters back from wagon road, 150 meters south and 50 meters west from northwest corner of fence inclosing partly cleared timber lot. To 4-inch maple, blazed, 175° (mag.)—11 meters.

Elevation cap on pipe, 691.69. Bolt in tile, 687.59.

T. B. M. 81, R. B. Is opposite buildings at Grey Cloud Landing, is nail in notch cut in leaning 14-inch willow tree; tree is about 30 meters from top of right bank and in edge of swale, leans towards river. Elevation, 692.97.

STONE LINE 256 (300 METERS BELOW PINE BEND LANDING, MINN.).

$\frac{256}{1}$. Tile and iron pipe 534.2 meters back from $\frac{256}{2}$, in timber. To 20-inch elm, blazed, 42° (mag.)—1.7 meters; to 18-inch elm, blazed, 180° (mag.)—2 meters; to 20-inch elm, blazed, 250° (mag.)—1.5 meters.

Elevation cap on pipe, 695.36. Bolt in tile, 691.39.

$\frac{256}{2}$. Tile and iron pipe on Grey Cloud Island, about 75 meters back from bank of river, at edge of heavy timber, 5 meters upstream from an old wagon road and in line with wing dam, which is opposite a point 300 meters below Pine Bend Landing. To 10-inch cottonwood, 178° 16′—6 meters; to 18-inch cottonwood, 181° 46′—4.2 meters.

Elevation cap on pipe, 700.19. Bolt in tile, 696.22.

$\frac{256}{3}$. Tile and iron pipe on right bank about 5 meters back from highest point of bank, 300 meters below Pine Bend Landing and 100 meters below ruins of rock foundation which stand on bank of river; also, 160 meters below a small running stream. To 15-inch cottonwood, blazed, 216° 45′—7 meters; to 24-inch cottonwood, blazed, 163° 15′—18.5 meters; to 18-inch cottonwood, blazed, 304° 15′—17 meters.

Elevation cap on pipe, 697.34. Bolt in tile, 693.37.

T. B. M. 80, L. B. Is nail in root of 4-inch maple, on side of sloping bank, on Grey Cloud Island, about 1 mile above stone line 256, opposite foot of island. Elevation, 692.24.

STONE LINE 257 (3 MILES BELOW NEWPORT, MINN., AT HEAD OF GREY CLOUD SLOUGH).

$\frac{257}{1}$. Tile and iron pipe at fork of Grey Cloud road, 1 mile below Pullman avenue, 400 meters north of bridge over Grey Cloud Slough, 1 meter east of west fence of branch of road running to the bridge and 4 meters south of angle in said fence and 6 meters north of gate in same fence.

Elevation cap on pipe, 759.49. Bolt in tile, 755.53.

$\frac{257}{2}$. Tile and iron pipe 5 meters back of edge of sand terrace, 100 meters from river bank, 40 meters above Grey Cloud Slough, and 125 meters from its head. To 18-inch elm, blazed, 50° 25′—12 meters; to 8-inch bur oak, blazed, 187° 55′—8 meters.

Elevation cap on pipe, 703.80. Bolt in tile, 699.83.

$\frac{257}{3}$. Tile and iron pipe on right bank back from willow towhead, 20 meters from slough in timber, and 5 meters below a dam. To 30-inch ash, blazed, 42° 11′—9 meters; to 30-inch cottonwood, blazed, 92° 11′—9.5 meters.

Elevation cap on pipe, 699.85. Bolt in tile, 695.88.

$\frac{257}{4}$. Tile and iron pipe 409 meters back of $\frac{257}{3}$ and 20 meters back of slough, 200 meters above lower end of slough, between slough and wagon road, 150 meters east of Chicago Great Western Railway.

Elevation cap on pipe, 724.93. Bolt in tile, 720.96.

U. S. P. B. M. 83. Is between St. Paul Park and Pullman, on north side of Tenth avenue and 1½ feet east of west right-of-way limit of Chicago, Burlington and Northern Railroad, being top of copper bolt in tile. Elevation, 757.62.

U. S. P. B. M. 84. Is top of cap on iron pipe set over P. B. M. 83. Elevation, 761.61.

U. S. P. B. M. 81. Is at St. Paul Park, at southwest corner of Broadway and Third street, on the Syndicate Block, on east end of doorstep, being top of copper bolt, leaded vertically, marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 752.57.

T. B. M. 70, L. B. About 1 mile below St. Paul Park bridge, at edge of sand terrace, and near end of spur siding, is highest point on bowlder, about 30 feet east of track and 200 feet north of ruins of large brick building. Elevation, 740.88.

STONE LINE 258 (AT LOWER END OF NEWPORT, MINN., AND 500 METERS ABOVE RAILROAD BRIDGE AT ST. PAUL PARK).

$\frac{258}{1}$. Tile and iron pipe on left bank 180 meters back of Chicago, Milwaukee and St. Paul Railway track, 1 meter south of an east-and-west fence at corner of cultivated field, 40 meters east of angle in fence; fence is south line of a street in lower end of Newport which runs by a platform station of Chicago, Burlington and Northern Railroad and crosses Chicago, Milwaukee and St. Paul Railway 100 meters below a signboard "1,500 feet to station," 775.2 meters back of B. M. $\frac{258}{2}$.

Elevation cap on pipe, 783. Bolt in tile, 779.05.

$\frac{258}{2}$. Tile and iron pipe on right of way of Chicago, Burlington and Northern Railroad Branch which runs to bridge at St. Paul Park at lower end of Newport, 7 meters east of center of track. To a large two-story white frame house, 312° 01′—43.2 meters; to 10-inch elm, blazed, 161° 16′—28 meters.

Elevation cap on pipe, 751.62. Bolt in tile, 747.65.

$\frac{258}{3}$. Tile and iron pipe 5 meters back from right bank of river, 500 meters above railroad bridge at St. Paul Park on Newport Island, 8 meters below wing dam which is first below warehouse at Newport on opposite side of river. To 12-inch elm, blazed, 309° 16′—4.9 meters; to 6-inch box elder, blazed, 245° 46′—6.2 meters; to 10-inch elm, blazed, 126° 46′—3.5 meters.

Elevation cap on pipe, 701.34. Bolt in tile, 697.38.

$\frac{258}{4}$. Tile and iron pipe one-half meter west of west right-of-way fence of Chicago Great Western Railway, about 500 meters above Invergrove Railroad station, 20 meters above upper end of a fill, and 35 meters above north line of wall of brick house.

Elevation cap on pipe, 720.68. Bolt in tile, 716.71.

U. S. P. B. M. 79. Is in Newport, Minn., on northeast corner of lot belonging to and at residence of Mr. H. A. Jones, opposite Chicago, Milwaukee and St. Paul Railway depot, being copper bolt in tile. Elevation, 747.03.

U. S. P. B. M. 80. Is top of cap on iron pipe set over P. B. M. 79, standing about one-half foot above ground. Elevation, 751.03.

U. S. P. B. M. 77. Is about 1¼ miles below High Wood, opposite foot of Pig Eye Lake, at west right-of-way fence of Chicago, Milwaukee and St. Paul Railway, on east side of fence, being a copper bolt in tile. Elevation, 713.17.

U. S. P. B. M. 78. Is top of cap on iron pipe set over P. B. M. 77. Elevation, 717.17.

STONE LINE 259 (AT SOUTH ST. PAUL, MINN.).

$\frac{259}{1}$. Tile and iron pipe on high ground in weeds, 852.9 meters back of $\frac{259}{2}$, 150 meters north of a small grove of large trees in hay field. To 6-inch double ash, 130° (mag.)—7.7 meters.

Elevation cap on pipe, 698.26. Bolt in tile, 694.28.

$\frac{259}{2}$. Tile and iron pipe on left bank, 30 meters back from water's edge on highest part of bank and 1 meter toward river from a wire fence, 50 meters below a wing dam on left bank, which is first dam above upper ice house in South St. Paul on opposite side of river. To 24-inch elm, blazed, 276° 41′—2 meters; to 10-inch elm, blazed, 149° 11′—5.5 meters.

Elevation cap on pipe, 700.04. Bolt in tile, 696.08.

$\frac{259}{3}$. Tile and iron pipe on right bank 1 meter back from top of revetted bank and on levee; 62 meters above upper ice house and 52½ meters above ice chute at South St. Paul. To corner of ice house 332° 41′—62.5 meters.

Elevation cap on pipe, 709.68. Bolt in tile, 705.71.

U. S. P. B. M. 75. Is 1,170 feet below depot at Dayton Bluff, 1,900 feet below the water tank, 1½ feet west of west fence of Chicago, Milwaukee and St. Paul Railway, at south end of gate, at runway leading to railroad embankment, being top of copper bolt in tile. Elevation, 705.18.

U. S. P. B. M. 76. Is top of cap on iron pipe set over P. B. M. 75. Elevation, 709.17.

T. B. M. 64, R. B. In South St. Paul, is top of horizontal railroad spike in side of willow tree near small shed, between two side tracks, and about 100 meters above ice house, immediately back of B. M. $\frac{259}{3}$. Elevation, 703.84.

STONE LINE 260 (ONE-HALF MILE BELOW DAYTON BLUFF AND 2 MILES BELOW LOWER BRIDGE AT ST. PAUL, MINN.).

$\frac{260}{1}$. Tile and iron pipe back of $\frac{260}{2}$, in pasture 40 meters toward river from railroad track. To 24-inch willow, blazed, 67° 58′—28.8 meters; to 18-inch willow, blazed, 114° 13′—13.8 meters; to 30-inch elm, blazed, 265° 28′—24.4 meters.

Elevation cap on pipe, 702.27. Bolt in tile, 698.28.

$\frac{260}{2}$. Tile and iron pipe on left bank on top of bank at edge of timber, about one-half mile below lower end of Dayton Bluff, about 25 meters above a small dry slough, 5 meters back of a Government stone with square top, and 4 meters from a Government light. To 15-inch willow, blazed, 262°—7.1 meters.

Elevation cap on pipe, 701.63. Bolt in tile, 697.65.

$\frac{260}{3}$. Tile and iron pipe on right bank about 3 meters back from top of bank and one-half mile below where bluff on left bank comes out to river, 60 meters below a wing dam which is first one above a point opposite lower end of rock revetment; a Government light is at lower end of rock revetment. (Not found September, 1897.)

$\frac{260}{4}$. Tile and iron pipe back from $\frac{260}{3}$ at edge of scattering willows and 75 meters upstream from a wire fence. To 6-inch double ash 27° 02′—1.7 meters; to 6-inch double willow, 173° 17′—13.7 meters; to 18-inch willow 284° 02′—39.3 meters.

Elevation cap on pipe, 700.96. Bolt in tile, 696.88.

U. S. P. B. M. 73. Is in lower end of St. Paul, on southeast side of retaining wall on southeast side of Schmidt & Constanz's brewery, about 120 feet north of railroad track and 30 feet from foot of bluff, being copper bolt in tile, now covered by wood and coal shed. Elevation, 706.98.

U. S. P. B. M. 74. Is top of cap on iron pipe set over P. B. M. 73. Elevation, 710.98.

U. S. P. B. M. 72. Is on St. Paul court-house, Fifth and Wabasha streets, on west end of doorsill at south entrance to basement, 6 inches from either wall, being top of copper bolt leaded vertically, marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 787.08.

U. S. P. B. M. 70. Is in St. Paul about 100 feet west of Jackson street, on north side of railroad tracks, opposite Diamond Jo freight depot, at east end of retaining wall, and 4 inches back of its face, being top of copper bolt in tile. Elevation, 711.53.

U. S. P. B. M. 71. Is top of cap on iron pipe set over P. B. M. 70. Elevation, 715.53.

U. S. P. B. M. 68. Is in St. Paul on left bank of river, on lower wing wall of Chicago Great Western Railway bridge, 4.8 feet from lower end of bridge seat course and 2.75 feet back from its front edge, being top of copper bolt leaded vertically, marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 710.04.

U. S. P. B. M. 67. Is in St. Paul, on left bank of river, on the shore pier of Wabasha Street Bridge, on northwest corner of upper pier, 6 inches from the bridge seat stone, being top of copper bolt leaded vertically, marked $\overset{\text{U. S.}}{\underset{\text{P. B. M.}}{\odot}}$. Elevation, 715.43.

U. S. P. B. M. 65. Is in St. Paul on southeast corner of Washington and Eagle streets, 9.2 feet from south side of Washington, 1 foot above old city storehouse which stands on east side of Eagle street, being top of copper bolt in tile 2½ feet underground. Elevation, 721.28.

U. S. P. B. M. 66. Is top of cap on iron pipe set over P. B. M. 65. Elevation, 725.28.

STONE LINE 261 (AT HIGH BRIDGE, ST. PAUL, MINN.).

$\frac{261}{2}$. Tile and iron pipe under high bridge on left bank between third pair of piers back from the river, 1.44 meters from southeast corner of west pier and 2.1 meters from northeast corner of same pier.

Elevation cap on pipe 710.56. Bolt in tile, 706.59.

$\frac{261}{3}$. Tile and iron pipe on right bank under high bridge, 1.2 meters northwest of pier which is the southeast one of four on right bank. To northwest corner of said pier 295° 35′.

Elevation cap on pipe, 712.55. Bolt in tile, 708.57.

St. Paul City B. M. 1203. Is on water table at northeast corner Seventh and Chestnut streets. Elevation city datum, 84.73. Memphis datum, 786.55.

St. Paul City B. M. 1132. Is on right bank of river on water table, at northeast corner of Fillmore and Sharkey streets. Elevation city datum, 14.21. Memphis datum, 716.10.

St. Paul City B. M. 1312. Is on square corner of catch-basin at northwest corner of View and Seventh streets. Elevation city datum, 92.53. Memphis datum, 794.34.

St. Paul City B. M. 1238. Is on water table at northeast corner of East Seventh and Sibley streets. Elevation city datum, 66.81. Memphis datum, 768.63.

Base of rail at St. Paul Union Station. Elevation, 712.78.

H. W. 1881 at St. Paul, Minn. Elevation, 711.12.

H. W. 1887 at St. Paul, Minn. Elevation, 709.91.

U. S. gauge at St. Paul, Minn. Is at foot of Jackson street, section nailed to piling reads up to 20 feet. Elevation of zero, 691.46.

STONE LINE 262 (3 MILES ABOVE HIGH BRIDGE AT ST. PAUL, MINN., AND ONE-FOURTH MILE BELOW LOWER END OF PIKE ISLAND).

$\frac{262}{1}$. Tile and iron pipe back of $\frac{262}{2}$, about 50 meters toward river from foot of bluff. The upper one of two small frame houses stands 54 meters northeast of B. M. To 15-inch willow, blazed, 85° 05′—4.7 meters; to 10-inch willow, blazed, 269° 35′—24.6 meters; to southeast corner of house, 224° 05′—54.7 meters.

Elevation cap on pipe, 704.40. Bolt in tile, 700.40.

$\frac{262}{2}$. Tile and iron pipe on left bank, one-fourth mile below lower end of Pike Island, 50 meters back from bank of river, at edge of cultivated ground and timber, 23 meters down river from a pair of 36 inch elm trees, 1 meter apart, which stand in cultivated field 10 meters back from edge of timber To 36-inch elm, blazed, 59° 17′—23.2 meters; to 36-inch elm, blazed, 136° 17′—35.2 meters; to 12-inch ash, blazed, 329° 47′—7.4 meters.

Elevation cap on pipe, 711.15. Bolt in tile, 707.17.

$\frac{262}{3}$. Tile and iron pipe on right bank, one fourth mile below lower end of Pike Island, 50 meters below a spring. A path leads from river to railroad track, 5 meters above B. M., which is 4 meters back from river opposite fifth bulldog pier below foot of Pike Island. To 6-inch cottonwood, blazed, 110° 33′—2.2 meters; to 12-inch cottonwood, blazed, 44° 48′—9.7 meters.

Elevation cap on pipe, 706.33. Bolt in tile, 702.36.

T. B. M. "Construction." Is about one-fourth mile above stone line 262, on right bank of river at corner of signal station at St. Paul Junction. T. B. M. was put in by some other United States survey party. Elevation, 759.82.

◬ Front Base. Tile and iron pipe on Fort Snelling Reservation on top of bluff, 5 meters from edge, station is on prolongation of line along southeast side of Bloomington road, in grass 20 meters northeast of garden patch, outside of two small stone buildings. Elevation cap on pipe, 818.42. Bolt in upper tile, 814.44.

In addition to usual mark of tile and pipe, as precaution against disturbance of mark by frost, a tile with copper bolt is buried and plumbed 3 feet underneath usual tile.

◬ Back Base. Tile and iron pipe on Fort Snelling Reservation, 3 meters east of Bloomington road opposite end of embankment in rifle range, 100 meters back of square tower on west side of road, about 1,500 meters back of end of Bloomington road near crest of bluffs. Elevation cap on pipe, 823.56. Bolt in tile, 819.60.

Sundial post. Is a square-cut monument at crest of bluff, in vicinity of southwest corner of reservation. Elevation, 883.81.

STONE LINE 263 (ONE-HALF MILE BELOW SOLDIERS' HOME, ST. PAUL, MINN.).

$\frac{263}{1}$. Tile and iron pipe on left bank at foot of bluffs, at edge of grass field and timber, 200 meters back from river and 150 meters above lower end of grass field. To 6-inch basswood, blazed, 240° 03′—2 meters; to 8-inch oak, blazed, 239° 03′—6.8 meters.

Elevation cap on pipe, 714.34. Bolt in tile, 710.37.

$\frac{263}{2}$. Tile and iron pipe on right bank one-half mile below Soldiers' Home and 200 meters below foot of island, the head of which is opposite Soldiers' Home. On high bluff bank and 15 meters back from edge and 30 meters upstream from a small cabin which stands at foot of bluff bank where same leaves river. To 4-inch linn, blazed, 218° 12′—10.5 meters; to 6-inch ash, blazed, 294° 57′—4.2 meters; to 9-inch elm, blazed, 345° 57′—12.4 meters.

Elevation cap on pipe, 737.27. Bolt in tile, 733.29.

Preparations are being made to extend the secondary triangulation and precise level work northward from St. Paul, Minn. A small party is already in the field engaged in locating positions for the triangulation stations, and the main party will take the field about the last of May.

LOW-WATER SURVEY, SCOT BLUFF (828) TO CARROLLTON, LA. (957).

The low-water survey from Vicksburg to Donaldsonville, made in the winter of 1895-96, followed a period of several years of low-stage effects. In my report of last year (pp. 3673-3674, Mississippi River Commission Report, 1897) is the following statement:

"The relation existing between the stage and movement of sediment has an important bearing on these comparisons. It should therefore be remembered that the first survey was made just after one of the greatest known floods, and a good share of it was on the rising phase of the next flood, which was also a great one; while the last survey was made just after two seasons of unusually low water, much of it being made during the lowest known stage. During the last survey there was little or no slope in the river from Baton Rouge to Donaldsonville. Such sediment as reached this section was necessarily deposited in the bed under these conditions, but it may be swept out again by the next flood. This should be determined by another survey after the flood has subsided before any reliable conclusion as to permanent changes in the bed can be reached."

In accordance with the above recommendation a survey was made in December, 1897, and January, 1898, during the low-water season following the great flood of 1897.

The survey party was in charge of Assistant Engineer A. T. Morrow, assisted by F. F. Axtell and W. H. Roper, topographers; C. G. Weyl, leveler; T. C. Hockridge and L. C. Dziatzko, hydrographers, and a number of boatmen and axmen, besides the steamboat crew. This party was quartered on the steamer *Patrol* and survey boat *Illinois*. A steam launch, *Cygnet*, was hired for use in sounding. The work began at Scot Bluff (828) on December 6 and extended to Carrollton (957), which point was reached on January 29.

The survey consisted of location of shore line and the topography with elevations and 5-foot contours to the top of high-water banks, a line of levels determining the elevations of water surface at frequent intervals, soundings on cross sections located normal to the general direction of the river and about 220 meters apart.

About three-fourths of the work was completed when a rise set in that gradually reached nearly the bank-full stage at the close of the work.

In this work there were 16,732 points located with transit, 16,653 elevations above water determined, and 29,216 soundings were taken. From these data sections were platted and compared with corresponding sections of the survey of 1895-96, and the results are shown in the appended tabulation.

TABLE No. 5.—*Comparison of cross-section elements, Scot Bluff, La., to Donaldsonville, La., surveys of 1882–83, 1895–96, and 1897–98.*

AT LOW WATER.

NOTE.—The stretches are derived by dividing the river into lengths covering the alternate pools and crossings. The low-water plane used in these tables coincides with the stage of 1895–96 as given in column 4.

Distance from Cairo.	No. of stretch.	Average elevation above Memphis datum of stage when sounded.			Average width of cross sections.			Average area of cross sections.			Average mean depth at low water.			Average maximum depth at low water.		
		1882–83.	1895–96.	1897–98.	1882–83.	1895–96.	1897–98.	1882–83.	1895–96.	1897–98.	1882–83.	1895–96.	1897–98.	1882–83.	1895–96.	1897–98.
Miles.		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
830.5	85	23.1	8.2	10.3	2,022	2,256	2,211	126,520	120,417	127,783	61.6	52.5	57.1	101.7	98.8	100.1
835.0	86	27.7	8.8	10.3	2,244	2,466	2,472	97,752	94,138	99,964	44.0	38.8	41.0	66.9	60.5	63.7
839.6	87	29.9	9.1	10.4	2,653	2,732	2,724	93,011	93,094	93,601	36.0	35.0	35.6	73.4	68.9	73.5
842.9	88	30.4	9.1	10.7	2,314	2,437	2,525	102,382	102,196	110,078	47.7	46.8	48.9	101.3	96.0	102.5
846.4	89	31.5	8.4	10.0	2,329	2,540	2,589	106,785	102,250	102,517	46.0	40.4	39.8	65.7	65.0	64.3
849.8	90	32.5	8.5	9.8	2,385	2,447	2,316	115,032	108,175	110,573	49.5	45.7	50.0	103.9	98.5	105.5
851.5	91	33.0	8.1	9.5	2,756	2,816	2,722	107,088	105,600	113,816	40.5	39.7	42.8	69.0	63.7	76.0
857.4	92	33.1	8.3	9.4	2,225	2,343	2,351	105,429	103,691	120,320	49.4	46.5	53.8	102.8	97.4	117.8
861.3	93	32.7	8.1	9.8	2,833	2,928	2,893	108,440	104,484	110,980	40.8	37.2	39.8	73.3	70.3	76.5
864.0	94	33.0	8.1	10.0	2,251	2,267	2,309	135,231	119,804	116,298	62.4	55.2	57.7	116.4	97.3	109.0
866.0	95	32.8	8.2	10.5	2,624	2,742	2,780	117,432	110,248	108,488	45.8	41.2	39.6	86.7	63.6	69.3
870.6	96	32.8	8.4	10.6	2,564	2,487	2,546	122,902	110,303	122,303	53.4	47.6	53.4	107.6	98.2	109.7
872.8	97	32.2	8.5	10.7	2,533	2,650	2,690	113,470	111,300	114,627	45.5	42.6	43.4	68.5	59.4	68.2
877.0	98	32.1	8.6	10.5	2,519	2,493	2,474	116,055	111,120	115,247	50.0	47.1	49.4	94.9	89.9	95.7
879.6	99	31.8	9.3	10.6	2,640	2,640	2,674	112,069	115,297	110,349	42.4	43.9	40.9	63.8	61.8	63.6
882.3	100	31.7	9.2	10.6	2,277	2,360	2,266	150,810	132,086	147,783	69.4	58.1	68.1	116.9	97.5	120.2
885.3	101	31.2	8.7	10.5	2,362	2,318	2,467	140,593	139,833	145,773	61.3	61.9	60.9	111.4	106.5	115.2

AT MEDIUM STAGE.

[The medium stage used in these tables corresponds to the mean of the highest and lowest water of 1882 (see Report Miss. River Com., 1890, p. 3129).]

Distance from Cairo.	No. of stretch.	Average elevation above Memphis datum of—				Average width of cross sections.			Average area of cross sections.			Average mean depth at medium stage.		
		Medium stage.	Stage when sounded.											
			1882–83.	1895–96.	1897–98.	1882–83.	1895–96.	1897–98.	1882–83.	1895–96.	1897–98.	1882–83.	1895–96.	1897–98.
Miles.		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*
830.5	85	29.3	23.1	8.2	10.3	2,505	2,544	2,466	174,905	170,417	177,160	69.6	66.0	71.3
835.0	86	28.5	27.7	8.8	10.3	2,541	2,708	2,706	144,222	144,584	150,371	57.7	53.9	56.3
839.6	87	27.8	29.9	9.1	10.4	3,107	3,349	3,367	146,683	149,428	149,103	47.7	45.0	44.8
842.9	88	27.4	30.4	9.1	10.7	2,747	2,952	3,006	150,491	152,913	161,104	56.3	54.3	56.7
846.4	89	26.9	31.5	8.4	10.0	2,517	2,749	2,788	151,315	150,680	151,287	60.2	54.7	54.5
849.8	90	26.5	32.5	8.5	9.8	2,603	2,915	2,872	160,748	157,002	158,067	63.5	55.1	56.6
851.5	91	26.2	33.0	8.1	9.5	2,922	3,092	3,074	158,612	158,952	165,256	56.0	52.7	54.9
857.4	92	25.7	33.1	8.3	9.4	2,463	2,594	2,624	146,299	147,269	163,331	61.0	58.2	64.3
861.3	93	25.3	32.7	8.1	9.8	2,959	3,092	3,111	157,432	155,564	162,764	55.0	51.3	53.7
864.0	94	24.9	33.0	8.1	10.0	2,462	2,512	2,548	174,809	160,087	167,718	72.4	65.3	67.7
866.0	95	24.7	32.8	8.2	10.5	2,782	2,928	2,912	161,456	156,868	154,488	59.1	54.5	53.4
870.6	96	24.4	32.8	8.4	10.6	2,792	2,945	2,865	165,802	154,340	165,003	63.8	55.6	61.8
872.8	97	24.0	32.2	8.5	10.7	2,710	2,858	2,882	154,030	154,573	158,220	57.7	55.1	55.7
877.0	98	23.7	32.1	8.6	10.5	2,733	2,931	2,905	155,607	152,435	156,038	60.9	54.7	57.1
879.6	99	23.4	31.8	9.3	10.6	2,763	2,889	2,861	148,712	152,726	146,314	53.9	53.0	51.3
882.3	100	23.1	31.7	9.2	10.6	2,647	2,660	2,464	186,423	169,306	181,331	94.8	64.9	76.9
885.3	101	22.8	31.2	8.7	10.5	2,505	2,582	2,507	175,680	175,157	183,467	71.5	68.8	73.8

TABLE NO. 5.—*Comparison of cross-section elements, Scot Bluff, La., to Donaldsonville, La., surveys of 1882-83, 1895-96, and 1897-98*—Continued.

AT BANK-FULL STAGE.

[The bank-full stage used in these tables corresponds to the average elevation of the top of the bank.]

Distance from Cairo.	No. of stretch.	Average elevation above Memphis datum of—				Average width of cross sections.			Average area of cross sections.			Average mean depth at bank-full stage.		
		Bank-full stage.	Stage when sounded.											
			1882-83.	1895-96.	1897-98.	1882-83.	1895-96.	1897-98.	1882-83.	1895-96.	1897-98.	1882-83.	1895-96.	1897-98.
Miles.		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*
830.5	85	40.0	23.1	8.2	10.3	2,742	2,707	2,631	202,836	198,303	204,606	74.6	72.1	77.2
835.0	86	40.0	27.7	8.8	10.3	2,784	2,829	2,843	174,093	175,593	181,797	63.7	62.8	64.4
839.6	87	38.3	29.9	9.1	10.4	3,331	3,527	3,482	180,856	179,057	186,003	55.4	52.7	53.8
842.9	88	39.7	30.4	9.1	10.7	3,217	3,144	3,155	186,117	190,340	202,635	59.1	62.8	65.7
846.4	89	38.2	31.5	8.4	10.0	2,748	2,878	2,866	181,812	183,057	183,043	66.6	63.8	63.7
849.3	90	38.0	32.5	8.5	9.8	3,215	3,088	3,046	198,152	191,152	191,780	61.0	63.2	62.9
851.5	91	37.8	33.0	8.1	9.5	3,194	3,246	3,180	193,524	195,552	200,824	62.0	61.4	64.4
857.4	92	36.6	33.1	8.3	9.4	2,606	2,728	2,776	174,096	176,760	192,660	65.5	65.9	70.5
861.3	93	35.2	32.7	8.1	9.8	3,297	3,277	3,229	188,128	186,896	193,588	58.5	58.0	60.9
864.0	94	34.9	33.0	8.1	10.0	2,852	2,687	2,736	200,787	186,553	194,080	70.7	71.0	72.5
866.0	95	35.0	32.8	8.2	10.5	2,942	3,036	3,052	190,816	190,924	185,032	65.2	63.7	61.8
870.6	96	34.4	32.8	8.4	10.6	2,990	3,037	3,082	195,802	185,310	195,487	68.7	64.0	67.8
872.8	97	33.4	32.2	6.5	10.7	2,823	2,952	2,995	179,490	181,403	185,140	64.6	62.1	62.6
877.0	98	32.8	32.1	8.6	10.5	3,233	3,170	3,169	182,015	180,224	183,475	57.5	59.4	61.0
879.6	99	33.6	31.8	9.8	10.6	2,944	2,981	3,049	176,800	181,977	175,823	60.1	61.1	57.9
882.3	100	32.5	31.7	9.2	10.6	3,217	2,916	2,683	213,617	196,187	207,543	68.6	68.4	80.6
885.3	101	33.0	31.2	8.7	10.5	2,737	2,730	2,638	201,293	200,283	209,111	74.1	74.8	80.8

TABLE NO. 6.—*Averages of cross-section elements.*

NOTE.—In determining the grand mean of the elements here given, the distances between sections and lengths of stretches are taken into account.

LOW WATER.

	Average widths.			Average areas.			Average mean depths.			Average maximum depths.		
	1882-83.	1895-96.	1897-98.	1882-83.	1895-96.	1897-98.	1882-83.	1895-96.	1897-98.	1882-83.	1895-96.	1897-98.
Bends......	2,333	2,391	2,402	121,157	114,119	122,895	54.8	50.2	54.6	105.3	97.2	108 1
Crossings..	2,554	2,677	2,682	104,989	102,550	104,954	42.2	39.2	39.9	70.4	64.6	69.1
MEDIUM STAGE.												
Bends......	2,609	2,753	2,737	163,730	157,616	164,512	66.6	59.8	62.9	......	......	......
Crossings..	2,687	2,964	2,972	151,454	151,746	153,848	55.5	48.0	52.9	......	......	......
BANK-FULL STAGE.												
Bends......	2,975	2,925	2,909	191,300	187,475	196,528	66.0	66.0	70.4	......	......	......
Crossings..	3,006	3,102	3,095	182,033	182,829	185,808	61.5	60.1	61.5	......	......	......
BENDS AND CROSSINGS COMBINED.												
Low water.	2,427	2,516	2,524	114,256	109,068	115,062	49.4	45.4	48.2	90.4	83.0	91.6
Medium stage....	2,687	2,844	2,840	158,146	155,053	159,856	61.8	54.8	58.5	......	......	......
Bank-full stage....	2,988	3,003	2,990	187,688	185,446	191,845	64.1	63.5	66.5	......	......	......

TABLE No. 7.—*Summary of changes in mean elements, Scot Bluff to Donaldsonville, surveys of 1895–96 and 1897–98.*

[In this comparison 1895–96 is taken as standard.]

AT LOW WATER.

Elements.	Bends.	Crossings.	Entire reach.
Width	Increased 11 feet, or $\frac{5}{10}$ of 1 per cent.	Increased 5 feet, or $\frac{2}{10}$ of 1 per cent.	Increased 8 feet, or $\frac{3}{10}$ of 1 per cent.
Area	Increased 8,776 square feet, or 7½ per cent.	Increased 2,404 square feet, or 2½ per cent.	Increased 5,994 square feet, or 5½ per cent.
Mean depth	Increased 4.6 feet, or 9 per cent.	Increased 0.7 foot, or 2 per cent.	Increased 2.8 feet, or 6 per cent.
Maximum depth	Increased 10.9 feet, or 11 per cent.	Increased 4.5 feet, or 7 per cent.	Increased 8.6 feet, or 10.4 per cent.

AT MEDIUM STAGE.

Width	Decreased 16 feet, or $\frac{6}{10}$ of 1 per cent.	Increased 8 feet, or $\frac{3}{10}$ of 1 per cent.	Decreased 4 feet, or $\frac{14}{100}$ of 1 per cent.
Area	Increased 6,896 square feet, or 4.2 per cent.	Increased 2,102 square feet, or 1.4 per cent.	Increased 4,803 square feet, or 3.1 per cent.
Mean depth	Increased 3.1 feet, or 5.4 per cent.	Increased 4.9 feet, or 10 per cent.	Increased 4.2 feet, or 8 per cent.

AT BANK-FULL STAGE.

Width	Decreased 16 feet, or $\frac{6}{10}$ of 1 per cent.	Decreased 7 feet, or $\frac{2}{10}$ of 1 per cent.	Decreased 13 feet, or $\frac{4}{10}$ of 1 per cent.
Area	Increased 9,048 square feet, or 4.9 per cent.	Increased 2,979 square feet, or 1.6 per cent.	Increased 6,399 square feet, or 3.4 per cent.
Mean depth	Increased 4.4 feet, or 6.8 per cent.	Increased 1.4 feet, or 2.4 per cent.	Increased 3 feet, or 4.8 per cent.

An inspection of the above tabulation shows quite conclusively that low-stage conditions tend to engorge the channel and high-stage conditions sweep out this engorgement.

In the report of last year, giving the comparisons between the surveys of 1882–83, made after a great flood and during a succeeding flood, with the survey of 1895–96, made after a period of three years of low-stage effects, it is shown that great deterioration in channel capacity had taken place.

In the above tables a comparison of the survey of 1895–96 with the survey of 1897–98, made after the great flood of 1897, shows a marked increase in channel capacity, bringing it back to nearly the same conditions found in 1882–83. The areas and maximum depths are, in fact, somewhat greater than they were in 1882–83. This goes far toward proving that stage is the principal factor governing the raising or lowering of the bed of the Mississippi River, at least in that part of the river under consideration.

The results are shown graphically on plates 1 and 2. Plate 1 shows the section of river covered and the lengths where the mean low-water bed of 1898 was higher or lower than in 1896. Plate 2 shows the mean elements of the stretches and gives a clear, graphical representation of the changes that have occurred.

This subject will be further discussed when the observations, Donaldsonville to Carrollton, have been reduced and tabulated.

PRECISE LEVELS, BATON ROUGE TO END OF JETTIES AT MOUTH OF SOUTH PASS.

The line of precise levels which was run between New Orleans and end of East Jetty in 1892–93 showed that the lower end of the delta of the Mississippi was subsiding. (See Mississippi River Commission Report, 1894, pp. 2794–2797, and 1896, pp. 3478–3484.) The rate of subsidence and the length of the delta affected are both important questions to solve. It was therefore determined to relevel the line from the hills at Baton Rouge to the end of the jetties.

A double precise level party under W. S. Williams, assisted by E. J. Thomas, was put in the field with the low-water survey party on December 6, 1898. They continued with this party until New Orleans was reached, when the steamer *Patrol* was turned over to them. The work was completed to the end of East Jetty on March

19, and the party and outfit arrived at New Orleans on March 21, where they were turned over to Major Quinn for use in the survey of Southwest Pass. The notes of the season's work are now being reduced. The preliminary results indicate that the subsidence at Port Eads has continued.

CARE AND REPAIR OF GAUGES.

There are 14 regular gauges maintained by the commission on the Mississippi River between St. Louis, Mo., and Fort Jackson, La. One gauge is maintained on the White River at Clarendon, and one on the St. Francis River at the crossing of the St. Louis, Iron Mountain and Southern Railway. A self-registering tide gauge is located at Biloxi, Miss.

All of the gauges on the main river were inspected and repaired in May and June, 1897; November and December, 1897; January, 1898; and in April, May, and June, 1898.

The gauge at Biloxi was inspected on April 25, 1898. A line of precise levels was run connecting the gauge and gauge benches with the precise bench marks on both sides of Biloxi Bay. Two of these benches on each side of the bay were connected with. One of these benches on each side of the bay is so situated as to be quite stable, and shows no signs of having been disturbed. These benches are U. S. C. & G. S. B. M. E_1, 1885–6, on the east side of the bay; and U. S. C. & G. S. B. M. H_1, 1885–6, on the west side of the bay. This last bench mark is the same as M. R. C. P. B. M. 19, 1882–3.

The other benches connected with are P. B. M. D_1, Coast and Geodetic Survey, at Ocean Springs. This bench is in the base of a chimney whose foundation is defective, causing such unequal settlement as to crack the structure. P. B. M. Coast and Geodetic Survey on the west side of the bay is identical with P. B. M. 20, Mississippi River Commission. It is a stone post set in top of the railroad embankment near the edge of same. As a bench mark so situated is very apt to settle its elevation is considered doubtful.

None of the other original bench marks were near enough to connect with, the nearest being several miles away; hence the mean values of the benches which had every appearance of being stable were adopted in determining the elevation of the zero of the staff gauge.

This elevation is 14.857 feet above the Cairo datum. The elevation as determined when gauge was set in 1882 was 14.802 feet. The elevation of zero as determined from B. M. E_1, when the present gauge was set in October, 1895, was 14.836 feet.

The end of October, 1898, will complete a continuous record of three years duration. This record has been an exceptionally good one throughout and will give all of the data necessary for deducing a close value for elevation of mean Gulf level.

Inspection of the regular gauges developed the following discrepancies:

Cape Girardeau, Mo.—This gauge was inspected June 30, 1897, and found to be correct. The stage was 20.5 feet at time of inspection and the lower sections could not be examined.

At Belmont the observer put in a temporary section which was 0.33 foot too low. This section was used from June 1 to 13, inclusive. The readings for these dates were corrected by subtracting 0.33 foot. From 23 feet up the gauge was 0.12 foot too low, and the readings were corrected by subtracting that amount.

The low-water inspection of November 8, 1897, found the low-water section 0.12 foot high. A correction of 0.1 foot was added to readings from September 13 to October 12, 1897.

The inspection of June 2, 1898, showed the section reading 18 to 49 feet to be correct. A new section reading 42 to 49 feet was put in where eddy effect would be avoided.

New Madrid, Mo.—June 28, 1897, the gauge was found to be correct to the nearest half-tenth of a foot. On November 10, 1897, the sections from 0 to 10 feet were found to be from 0.05 to 0.1 foot too high. A correction of 0.1 foot was therefore added to all readings from August 21 to November 10, 1897. On June 2, 1898, the sections above 23 feet were examined and all found to be correct within a half-tenth of a foot.

Cottonwood Point, Mo.—On June 26, 1897, the gauge was found correct to the nearest half-tenth, from the 13-foot mark up to high-water mark. On November 11, 1897, a discrepancy of 3.59 feet was found in the low-water section of gauge. The greater part of this error probably occurred when the stage passed below the zero of the gauge. The observer, in following the stage down with his temporary stakes, failed to distinguish between readings above zero and those below the zero. He also failed to leave the temporary stakes to be checked by the levels of the gauge inspector. Hence, the range of stage and time covered by the error found could only be determined by comparing with the New Madrid gauge. A coordinate plat from that gauge gives corrections ranging from —0.1 to —3.6 feet covering the stage from about 6.0 to —1.5 feet between August 28 and November 11, 1897. On November 12, 1897, the gauge and bulletin were moved about 1,000 meters upstream, on account of the deposit which had accumulated around the old gauge site. The elevation of the zero of the gauge was changed from 250.62 feet to 250.67 feet, to compare to the slope of the stream between the two gauge sites.

On January 30, 1898, the gauge was again inspected and readings were found to be correct. On May 31, 1898, an inspection was made and the section reading from 18 to 26 feet was found to be 0.3 foot high, and the section reading from 35.5 to 43 feet was 0.12 foot low. The section from 18 to 28 feet was reset.

Fulton, Tenn.—The inspection of June 24, 1897, found all of the sections above water correct. On November 13, 1897, another inspection was made at low water and all sections found correct. High-water section was inspected on January 29, 1898, and found to be correct. The sections above 25 feet were inspected on May 28, 1898, and the section in the water was found 0.12 foot low. The sections were not reset.

Mhoons, Miss.—This gauge was inspected on June 21, 1897. The section reading 9 to 15 feet was found to be 0.15 feet high, and was reset at proper elevation. On November 15, 1897, the inspection showed that the gauge had been disturbed by a sliding bank extending from —3 to 32 feet. The sections were reset at proper elevation and the bulletin was repainted. The correction amounts to 0.1 foot from September 17 to November 15, 1897. January 27, 1898, the high sections of the gauge were again examined and found correct. The inspection of May 25, 1898, found all of the sections near the bulletin destroyed up to 32 feet, the sections above that being intact. The section in the water reading 25.36 was 0.38 foot low. All of the sections from 32 feet down to about 10 feet were temporary sections set by the observer. The corrections to some of these may be determined when low-water stage is reached.

Sunflower Landing, Mississippi.—The inspection was made on June 16, 1897, the gauge reading 18.3 feet. A correction of 0.1 foot was found on all sections above 33 feet. The low-water inspection was made November 21, 1897, the gauge reading 2.57. An error of 0.43 foot was found in the low-water section, which was too high. This discrepancy involves corrections ranging from 0.1 to 0.4 foot, and extending from September 1 to November 21, 1897. The error in gauge was due to caving banks. The gauge was reestablished from the 2 to the 13 foot mark. On January 25, 1898, a new high-water section was put in. The inspection of May 23, 1898, found everything correct.

Arkansas City, Ark.—On June 12, 1897, the gauge was inspected at a stage of 21.13 feet, and the gauge at this stage was found to be 0.12 too low. The sections reading from 14 to 26 require a subtractive correction of 0.1 foot, from 26 to 41 a similar correction of 0.2, and from 41 to 51 subtract 0.1 foot. On December 1, 1897, the gauge was inspected at a stage of 1.52 feet and found to be 0.12 high. This requires a correction of 0.1 foot from 12 feet to 7.8 feet. The gauge was rebuilt from —1.0 to 10 feet and from 16 to 22 feet. On January 22, 1898, an inspection was made at high water and a new section was put in, reading from 32 to 41 feet. The inspection of May 20, 1898, found everything correct within a tenth of a foot.

Greenville, Miss.—This gauge was inspected on June 11, 1897, at a stage of 18 feet. The greatest discrepancy found was 0.06 foot. A new section was set, reading from 11 to 21 feet. On December 2, 1897, the gauge was inspected at a stage of 1.7. A section set by the observer, reading from —3 to + 11 feet was found to be 0.09 high. This requires a correction of 0.1 foot to all readings taken between August 22 and date of inspection. All of the sections that were found to be in error were reset at proper elevation. An inspection was made on May 19, 1898, and all of the sections above water were found correct.

St. Joseph, La.—This gauge was inspected on June 4, 1897, at a stage of 38.5 feet. The section reading from 39 to 47 feet was found to be 0.06 foot low. The section reading 37 to 40 feet was 0.15 foot low. These sections were reset at correct elevation. The low-water inspection of December 10, 1897, at a stage of —0.14, showed a general disturbance of all the sections except the one in the water. These disturbances apparently occurred after the falling stage had passed the sections, hence no corrections are required. The entire gauge from 0 to 40 feet was rebuilt in 6 sections. The bulletin was repaired. The gauge was visited on January 14, 1898, when a new section was put in extending from 39 to 49, and bulletin was repainted. An inspection was made on May 17, 1898, and sections above water (38 feet) were found correct. A new section, reading from 34 to 40 feet, was put in.

Bayou Sara, La.—On June 1, 1897, an inspection was made at a stage of 40.5 feet. Section 41 to 46 was found to be 0.1 foot low. The next inspection was made December 21, 1897, at a stage of 2.0, and the section in the water was found to be 1.85 feet low, due to the settlement of the bank. The observer had read on his own temporary sections from 13 feet down. The error was considered cumulative from that point and corrections were applied accordingly. The entire gauge from —1 to 45 feet was rebuilt in 9 sections. The bulletin was repainted. An inspection was made on May 11, 1898, at a stage of 34.75 feet, and the sections above water were found to be correct. Two new gauge bench marks were established to take the place of B. M. A. Ewens, 1889, which will soon be destroyed by the removal of the brick house in which it is placed.

Plaquemine, La.—Gauge was inspected June 31, 1897, at a stage of 33.7 feet, and found to be correct. A new section, reading from 33 to 37 feet, was put in. A low-water inspection was made December 22, 1897, at a stage of 2.8 feet. The section in the water was found to be correct. The entire gauge at the regular gauge site was destroyed by sliding banks, and the gauge was rebuilt in six sections about 150 meters below the old site. On May 10, 1898, the gauge was inspected at a stage of 28.8 feet. The section in the water and above was found to be correct. The lower sections were reported by the observer as having been knocked out by the drift.

College Point, Louisiana.—This gauge was inspected December 23, 1897, at a stage of 1.64 feet. All sections up to 15 feet were found to be 0.1 foot too high. The entire gauge from 0 to 31 feet was rebuilt. The bulletin was repainted. The next inspection was made on May 9, 1898, at a stage of 22.19 feet, and gauge found to be correct.

Fort Jackson, Louisiana.—Gauge was inspected May 27, 1897, at a stage of 6.8 feet. Gauge found to be correct. It was again inspected on January 23, 1898, at a stage of 1.7 feet, and found correct. On May 6, 1898, another inspection was made and no error was found.

St. Francis River, St. Louis, Iron Mountain and Southern Railway Crossing.—This gauge was examined on June 23, 1897, and found to be in good condition. It was again inspected on May 27, 1898, and found correct.

The White River gauge at Clarendon, Ark., was inspected on May 24, 1898, and reported correct.

The high-water gauges between Cairo, Ill., and Fort Jackson, La., were read during the flood stage of 1898. The maximum elevations reached in 1898 is given in the following tabulation, which also shows the elevations on same gauges of the high water of 1897:

TABLE NO. 8.—*Maximum readings of high-water gauges in 1897 and 1898, with differences between the two.*

NOTE.—All gauges were read at or near the flood stage. Some were read before the crest was reached; these are indicated by * in elevation column. In such cases the maximum reading is obtained by interpolating the value of the rise after the first readings were made. These corrections occur at intervals between Cairo and Mhoons, where the interpolated value varies from 0.1 foot to 1.4 feet, and from Greenville to Vicksburg, from 0 to 0.2 foot.

Name of gauge.	Distance from Cairo.	Date of highest reading, 1898.	Regular gauge readings.	Maximum elevation above Memphis datum.		Differences compared with 1897.
				Flood of 1898.	Flood of 1897.	
	Miles.		*Feet.*	*Feet.*	*Feet.*	*Feet.*
Cairo	0.0	Apr. 6	49.78	327.5	329.4	—1.9
182	4.4	Apr. 6		*324.9	326.5	—1.6
181	8.9	Apr. 6		324.1	325.3	—1.2
180	12.5	Apr. 6		*323.0	324.3	—1.3
179	17.8	Apr. 6		*320.2	321.4	—1.2
Belmont	21.3	Apr. 6	43.98	317.7	318.7	—1.0
178	27.5	Apr. 6		*315.4	316.5	—1.1
177	33.5	Apr. 5–6		*313.0	314.2	—1.2
176	38.5	Apr. 5–6		310.5	312.0	—1.5
175	44.3	Apr. 5–6		308.4	309.7	—1.3
174	49.8	Apr. 5–6		306.5	308.0	—1.5
173	54.0	Apr. 5–6		305.4	306.9	—1.5
172	59.5	Apr. 6–7		304.7	306.4	—1.7
171	64.5	Apr. 7		*302.8	304.9	—2.1
New Madrid	70.3	Apr. 7–8	38.86	301.0	302.9	—1.9
170	73.3	Apr. 7–8		298.7	300.8	—2.1
169	78.7	Apr. 7–8		*296.3	298.3	—2.0
168	84.8	Apr. 7		294.8	296.3	—1.5
167	89.5	Apr. 8		*291.4	293.1	—1.7
166	95.0	Apr. 8		288.4	289.9	—1.5
165	99.3	Apr. 8		286.6	288.0	—1.4
164	103.8	Apr. 8–9		*285.0	286.4	—1.4
163	109.3	Apr. 8–9		282.3	283.3	—1.0
162	113.5	Apr. 8–9		*280.3	281.2	—0.9
161	118.5	Apr. 8–9		277.9	278.8	—0.9
Cottonwood Point	123.0	Apr. 8, 9, 10	38.53	276.1	276.8	—0.7
160	127.5	Apr. 8, 9, 10		274.8	275.7	—0.9
159	130.5	Apr. 8–9		*273.4	274.0	—0.6
158	135.0	Apr. 8–9		*272.2	273.0	—0.8
157	139.8	Apr. 8–9		270.2	270.8	—0.6
156	146.0	Apr. 8–9		*266.8	268.1	—1.3
155	152.8	Apr. 8–9		*263.6	264.0	—0.4
154	158.3	Apr. 8–9		*261.0	261.4	—0.4
153	161.8	Apr. 8–9		259.8	260.2	—0.4

TABLE NO. 8.—*Maximum readings of high-water gauges in 1897 and 1898, etc.*—Cont'd.

Name of gauge.	Distance from Cairo.	Date of highest reading, 1898.	Regular gauge readings.	Maximum elevation above Memphis datum.		Differences compared with 1897.
				Flood of 1898.	Flood of 1897.	
	Miles.		*Feet.*	*Feet.*	*Feet.*	*Feet.*
152	167.5	Apr. 10		258.0	258.3	—0.3
151	172.8			*254.7	254.8	—0.1
Fulton	175.4	Apr. 10	38.30	253.7	252.9	+0.8
150	180.1	Apr. 9		251.5	251.2	+0.3
149	186.3	Apr. 9 10		248.1	247.5	+0.6
148	192.3	Apr. 10-11		246.0	245.7	+0.3
147	197.3			*244.0	243.8	+0.2
146	203.3	Apr. 11		240.7	240.1	+0.6
145	208.0	Apr. 11		238.7	238.4	+0.3
144	212.8			*236.1	235.5	+0.6
143	220.3			233.7	233.3	—0.1
142	225.5	Apr. 9		229.4	229.3	+0.1
Memphis	230.0	Apr. 10	37.59	228.4	228.5	+0.1
141	235.0			*225.3	225.1	—0.2
140	239.5			*223.1	222.9	—0.2
139	244.3			*220.7	221.0	—0.3
138	249.5			217.8	218.2	—0.4
137	256.3			214.6	215.4	—0.8
136	261.3	Apr. 13-14		212.3	213.6	—1.3
135	266.8	Apr. 14-15		210.1	211.8	—1.7
134	271.0			*208.7	210.8	—2.1
Mhoon	277.3	Apr. 14, 15, 16	39.06	207.4	210.0	—2.6
133	280.5	Apr. 16		207.1	209.5	—2.4
132	284.3	Apr. 15-16		204.6	207.6	—3.0
131	289.5	Apr. 16		203.4	206.6	—3.2
130	293.5	Apr. 6		201.9	205.0	—3.1
129	297.8	Apr. 7		201.2	204.6	—3.4
128	301.5	Apr. 17		200.1	203.2	—3.1
Helena	306.5	Apr. 17	49.11	198.0	200.6	—2.6
127	312.5	Apr. 17-18		195.2	197.5	—2.3
126	317.8	Apr. 17-18		193.3	195.2	—1.9
125	323.5	Apr. 17-18		191.1	193.2	—2.1
124	329.3	Apr. 17-18		188.9	190.9	—2.0
123	334.5	Apr. 17-18		187.3	189.4	—2.1
122	339.0	Apr. 17-18		184.3	185.8	—1.5
121	342.5	Apr. 17, 18, 19		183.4	184.8	—1.4
120	346.8	Apr. 17, 18, 19		182.1	183.1	—1.0
Sunflower	352.7	Apr. 17, 18, 19	46.00	180.0	181.1	—1.1
119	357.0	Apr. 18 19		178.4	179.5	—1.1
118	362.0	Apr. 18 19		177.3	178.5	—1.2
117	366.8	Apr. 18-19		175.6	176.5	—0.9
116	371.8	Apr. 18-19		174.3	175.1	—0.8
115	378.0	Apr. 18-19		171.5	172.5	—1.0
114	383.5	Apr. 18-19		168.8	170.4	—1.6
113	389.5	Apr. 19		168.0	169.3	—1.3
Mouth of White River	393.2	Apr. 19	51.05	166.7	168.0	—1.3
112	398.5	Apr. 19		165.0	166.2	—1.2
111	401.8	Apr. 19 20		164.0	165.3	—1.3
110	408.0	Apr. 19 20		162.7	164.0	—1.3
109	412.0	Apr. 19 20		161.5	162.9	—1.4
108	416.8	Apr. 19-20		161.1	162.4	—1.3
107	421.5	Apr. 19, 20, 21		159.2	160.6	—1.4
106	427.0	Apr. 19, 20, 21		158.2	159.7	—1.5
105	432.5	Apr. 19-21		156.0	157.0	—1.0
Arkansas City	438.3	Apr. 19, 20, 21	51.14	154.5	155.2	—0.7
104	444.8	Apr. 20-21		151.5	152.4	—0.9
103	449.5	Apr. 19-20		150.8	151.6	—0.8
102	456.5	Apr. 20		147.8	148.6	—0.8
101	459.0	Apr. 20		147.3	148.2	—0.9
100	463.5	Apr. 21		146.7	147.3	—0.6
99	467.0	Apr. 21		146.0	147.0	—1.0
98	473.3	Apr. 21		143.4	144.0	—0.6
Greenville	478.3	Apr. 21	46.16	141.0	141.6	—0.6
97	482.5	Apr. 22		140.3	140.5	—0.2
96	487.0	Apr. 21		*139.4	139.7	—0.3
95	489.8	Apr. 21		*138.3	138.6	—0.3
94	495.3	Apr. 21-22		*136.4	136.9	—0.5
93	501.0	Apr. 21-22		*134.5	134.8	—0.3
92	505.5	Apr. 21-22		*133.2	133.8	—0.6
91	510.5	Apr. 21-22		*130.8	131.2	—0.4
90	517.0	Apr. 23		*128.8	129.0	—0.2
89	522.5	Apr. 21-22		*127.5	127.6	—0.1
88	525.8	Apr. 21-22		125.6	125.8	—0.2
87	531.5	Apr. 22-23		*123.9	123.8	+0.1
86	537.5	Apr. 21, 22, 23		*122.1	122.3	—0.2
Lake Providence	542.3	Apr. 23	44.35	120.8	121.0	—0.2

TABLE No. 8.—*Maximum readings of high-water gauges in 1897 and 1898, etc.*—Cont'd.

Name of gauge.	Distance from Cairo.	Date of highest reading, 1898.	Regular gauge readings.	Maximum elevation above Memphis datum.		Differences compared with 1897.
				Flood of 1898.	Flood of 1897.	
	Miles.		*Feet.*	*Feet.*	*Feet.*	*Feet.*
85	546.5	Apr. 23		*120.3	119.9	+0.4
84	552.3	Apr. 23		*118.0	117.9	+0.1
83	556.5	Apr. 23–24		*116.1	116.4	—0.3
82	561.3	Apr. 23–24		*114.7	115.4	—0.7
81	568.0	Apr. 23		111.1	112.2	—1.1
80	573.5	Apr. 24		*109.4	110.9	—1.5
79	578.0	Apr. 24		*108.0	109.8	—1.8
78	583.5	Apr. 24		*107.2	109.2	—2.0
77	588.5	Apr. 24–25		*105.1	108.0	—2.9
76	593.5	Apr. 24–25		*103.8	107.0	—3.2
Vicksburg	599.3	Apr. 24–25	49.40	102.3	105.4	—3.1
75	602.8	Apr. 24–25		*100.9	103.2	—2.3
74	607.5	Apr. 25		100.3	102.6	—2.3
73	612.5	Apr. 25		97.3	99.7	—2.4
72	617.5	Apr. 25		94.8	97.6	—2.8
71	622.0	Apr. 25		93.6	96.5	—2.9
70	627.5	Apr. 25–26		92.0	94.7	—2.7
69	633.0	Apr. 25–26		89.2	92.4	—3.2
68	638.0	Apr. 25–26		87.5	90.1	—2.6
67	642.8	Apr. 25–26		86.3	88.7	—2.4
St. Joseph	648.3	Apr. 25–26	45.10	84.7	87.5	—2.8
66	655.3	Apr. 26		81.6	84.4	—2.8
65	659.8	Apr. 26		80.0	83.4	—3.4
64	663.8	Apr. 26		79.4	82.6	—3.2
63	680.8	Apr. 26		78.4	81.6	—3.2
62	685.5	Apr. 26–27		77.4	79.9	—2.5
61	691.5	Apr. 26–27		74.9	77.5	—2.6
60	694.0	Apr. 26–27		73.4	76.2	—2.8
Natches	700.3	Apr. 26–27	47.40	71.2	73.6	—2.4
59	705.5	Apr. 26–27		69.8	72.4	—2.6
58	711.3	Apr. 26–27		68.9	71.5	—2.6
57	716.0	Apr. 27		68.1	70.8	—2.7
56	720.5	Apr. 27		66.5	69.3	—2.8
55	725.3	Apr. 27		65.2	68.0	—2.8
54	731.0	Apr. 27		62.8	66.3	—3.5
53	737.5	Apr. 27		61.6	65.4	—3.8
52	742.8	Apr. 28		60.0	64.3	—4.3
51	747.0	Apr. 27		59.9	63.6	—4.7
50	751.5	Apr. 27–28		57.9	63.2	—5.3
49	756.0	Apr. 27, 28, 29		56.4	62.3	—5.9
48	761.0	Apr. 27, 28, 29		55.5	61.5	—6.0
Red River Landing	765.8	Apr. 28–30	44.30	55.0	60.9	—5.9
47	769.0	Apr. 28–29		54.0	60.0	—6.0
46	772.5	Apr. 29–30		53.8	59.7	—5.9
45	779.8	Apr. 28, 29, 30		52.0	58.2	—6.2
44	784.8	Apr. 28–29		51.4	57.5	—6.1
43	790.5	Apr. 29–30		49.6	56.3	—6.7
42	794.5	Apr. 28–30–May 1		48.7	55.5	—6.8
Bayou Sara	799.8	Apr. 27–30–May 1	37.50	48.3	54.6	—6.3
41	803.5	Apr. 28–May 1		47.2	53.3	—6.1
40	808.0	Apr. 28–May 1		46.2	53.2	—7.0
39	812.5	Apr. 28–May 1		45.8	52.2	—6.4
38	817.0	Apr. 28–May 1		44.2	50.6	—6.4
37	822.5	Apr. 28–May 1		43.9	50.1	—6.2
36	828.5	Apr. 27–30		42.2	48.4	—6.2
Baton Rouge	833.3	Apr. 29–30–May 1	34.60	41.5	47.6	—6.1
35	839.5	Apr. 29–May 1		40.6	46.9	—6.3
34	844.8	Apr. 29–30–May 1		39.8	45.9	—6.1
33	850.0	Apr. 29–30–May 1		38.7	44.5	—5.8
Plaquemine	854.1	Apr. 29–30–May 1	30.60	38.5	44.2	—5.7
32	859.8	Apr. 29–May 1		37.5	43.0	—5.5
31	864.5	Apr. 28–May 1		36.8	42.1	—5.3
30	869.7	Apr. 28–May 1		35.9	41.3	—5.4
29	874.5	May 1–2		35.6	40.7	—5.1
28	880.0	Apr. 28–30		35.0	40.1	—5.1
Donaldsonville	885.4	Apr. 28–29	27.95	34.3	39.1	—4.8
27	889.8	Apr. 28–29		33.9	38.9	—5.0
26	895.8	Apr. 28–29		32.9	37.6	—4.7
25	900.3	Apr. 29		32.2	36.7	—4.5
College Point	904.5	Apr. 27–30	23.50	31.6	36.1	—4.5
24	910.5	Apr. 27–30		30.5	34.7	—4.2
23	914.8	Apr. 28		29.9	33.9	—4.0
22	919.8	Apr. 26–May 1		29.2	33.1	—3.9
21	925.5	Apr. 28		28.6	32.0	—3.4
20	930.5	Apr. 29–May 1		27.3	31.1	—3.8

TABLE No. 8.—*Maximum readings of high-water gauges in 1897 and 1898, etc.*—Cont'd.

Name of gauge.	Distance from Cairo.	Date of highest reading, 1898.	Regular gauge readings.	Maximum elevation above Memphis datum.		Differences compared with 1897.
				Flood of 1898.	Flood of 1897.	
	Miles.		*Feet.*	*Feet.*	*Feet.*	*Feet.*
19	934.8	Apr. 29–May 1		26.9	30.2	—3.3
18	937.8	Apr. 29–May 1		26.2	29.4	—3.2
17	943.5	Apr. 28–May 1		25.4	28.9	—3.5
16	948.0	Apr. 28–May 1		25.1	28.1	—3.0
15	953.0	Apr. 26, 28–May 1		24.2	27.2	—3.0
Carrollton	957.0	Apr. 25–May 1	15.90	23.7	26.95	—3.3
14	968.0	Apr. 26, 28–May 3		22.0	24.0	—2.0
13	973.5	Apr. 25–27		20.9	23.3	—2.4
12	979.5			19.8	22.1	—2.3
11	983.5			19.1	21.0	—1.9
10	989.8	Apr. 26–29		18.6	20.4	—1.8
9	993.0	Apr. 26–29		17.7	19.4	—1.7
8	999.0	Apr. 26–29		17.4	19.1	—1.7
7	1,003.8	Apr. 25–30		16.5	18.1	—1.6
6	1,008.8			16.4	17.4	—1.0
5	1,013.0	Apr. 24–30		15.7	16.9	—1.2
4	1,019.	Apr. 20–30		14.6	15.9	—1.3
3	1,023.8			14.4	15.5	—1.1
2	1,029.0	May 2–4		13.9	14.8	—0.9
1	1,034.0	Apr. 25		13.8	14.0	—0.7
Fort Jackson	1,039.0	Apr. 23–26	6.70	12.8	13.3	—0.5

In the vicinity of Fulton, Tenn., the stage reached 0.8 foot higher than that of 1897, although it was 1.9 feet lower at Cairo. In the vicinity of Lake Providence the stage of 1898 was also slightly higher than in 1897, the difference ranging from 0 to 0.3 foot. At all other points the stage of 1898 was lower than that of 1897, the difference ranging between 6 and 7 feet between Red River Landing and Plaquemine.

A profile is appended showing the high waters of 1883, 1892, 1897, and 1898, and the low water of 1895.

The following tables give the highest and lowest stages reached at various points, with dates of same down to 1898:

TABLE No. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges.*

NOTES.—The † before a quantity indicates that the gauge record is incomplete, and that possibly the period of extreme high or low water is not included. Extreme readings for each station are in heavy-face type.

MISSISSIPPI RIVER.—HASTINGS, MINN. (893 MILES ABOVE CAIRO.)

[United States Engineer gauge; zero 690.79 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1870		8.78			High-water mark.
1879	July 12, 13	†10.70	Nov. 24	0.7	United States Engineer gauge records.
1880	June 17	16.80	Oct. 11, 14, 15	1.7	
1881	Apr. 30	**18.00**	Aug. 15, 16	3.5	
1882	Apr. 12, 13	13.70	Dec. 12–15	2.4	
1883	Apr. 24–26	13.10	Nov. 16–18	1.0	
1884	May 6	11.20	Aug. 16	1.7	
1885	Apr. 28–30	9.20	Dec. 5	1.0	
1886	Apr. 20, 21	10.00	Nov. 20	0.8	
1887	Apr. 18, 19	11.00	Nov. 28–30	0.1	
1888	May 11	14.30	Dec. 13, 14	0.8	
1889	May 21–23	4.20	Nov. 28–30	— 0.4	
1890	June 12, 24	6.6	Dec. 1	— 0.4	
1891	Apr. 26	6.95	Nov. 21, 22	— 0.65	
1892	May 26	13.1	Nov. 23	**—0.7**	
1893	May 6	14.8	do	0.1	
1894	May 20, 21	13.0	Aug. 6	— 0.5	
1895	June 16	5.8	Dec. 2, 26, 27	— 0.2	
1896	May 21	12.6	Mar. 23 Sept. 7, Nov. 23	— 0.6 0.7	
1897	Apr. 6	17.0	Nov. 28–30	0.8	

TABLE NO. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

MISSISSIPPI RIVER.—WINONA, MINN. (795 MILES ABOVE CAIRO.)

[United States Engineer gauge; zero 660.34 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1878	....	....	Sept. 19	†0.08	United States Engineer gauge records.
1879	July 17, 18	9.00	Mar. 27	†0.71	
1880	June 18	**16.87**	Oct. 14	1.54	
1881	Oct. 5	14.33	Apr. 7	2.70	High water, United States Engineer gauge records. Low water, Mississippi River Commission discharge party gauge records.
1882	Apr. 13, 14	11.83	Dec. 6	2.42	United States Engineer gauge records.
1883	Apr. 21	12.17	Nov. 30, Dec. 1	1.00	
1884	Sept. 16	11.33	Jan. 2 Aug. 17	1.04 1.12	
1885	May 1, 2	8.83	Dec. 5, 6	1.92	
1886	Apr. 23	10.63	Nov. 29	− 0.29	
1887	Apr. 20	10.92	Nov. 28–30	0.75	
1888	May 4, 8	14.92	Dec. 22	1.33	
1889	May 25	5.25	Dec. 30	**−1.33**	
1890	June 12–14	8.2	Jan. 1 Dec. 25	− 0.2 1.2	
1891	Apr. 28	8.79	Nov. 26, 27	− 0.83	
1892	May 26, 27	12.1	Nov. 24	1.1	
1893	May 16	12.6	.....do	1.1	
1894	May 21	13.3	Aug. 10, 11	0.4	
1895	June 18–20	7.1	Dec. 1, 24	1.1	
1896	Apr. 23, 24	12.3	Jan. 6 Sept. 2, 3, 8, 9	0.8 1.6	
1897	Apr. 9	16.5	Nov. 30	2.2	

MISSISSIPPI RIVER.—PRAIRIE DU CHIEN, WIS. (690 MILES ABOVE CAIRO.)

[United States Engineer gauge; zero 625.08 feet above the Cairo datum plane.]

1878	....	....	Dec. 12	†1.00	United States Engineer gauge records.
1879	May 26	10.40	Sept. 26–30	1.80	
1880	June	**21.8**	Nov. 29, 30	2.00	High-water mark. Low water, United States Engineer gauge records.
1881	Oct. 21	19.50	Aug. 23–25	3.70	United States Engineer gauge records.
1882	Apr. 19	15.10	Oct. 1, 5, 7–Dec. 9–11	3.50	
1883	Apr. 26	15.80	Nov. 18–20	1.30	
1884	Sept. 22	13.70	Aug. 16–20, Nov. 29	3.00	
1885	May 5, 6	11.75	Dec. 6	1.45	
1886	Apr. 27	14.45	Nov. 28	1.15	
1887	Apr. 23	14.25	Nov. 21	1.55	
1888	May 13	20.60	Dec. 16	1.45	
1889	May 28, 29	7.00	Dec. 30	**0.40**	
1890	June 27	12.00	Jan. 1 Dec. 7	1.3 1.6	
					For later years see North McGregor.

MISSISSIPPI RIVER.—NORTH M'GREGOR, IOWA. (689 MILES ABOVE CAIRO.)

[United States Engineer gauge; zero 625.45 feet above the Cairo datum plane.]

1880	June 22	**21.5**	....	....	United States Weather Bureau.
1891	Apr. 28–30	13.0	Nov. 28	0.6	United States Engineer gauge records.
1892	May 31	15.2	Nov. 23	1.1	
1893	May 10, 11	15.1	Nov. 27, 28	0.9	
1894	May 26	15.3	Aug. 16, 17	**0.3**	
1895	June 22–25	6.6	Sept. 9, 10	†0.5	
1896	May 29	13.1	Oct. 17, 18	†0.6	
1897	Apr. 13, 14	17.6	Nov. 28	1.5	

TABLE NO. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries referred to present or most recent gauges*—Continued.

MISSISSIPPI RIVER.—HANNIBAL, MO. (329 MILES ABOVE CAIRO.)

[Bridge gauge; zero 469.60 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1879	June 3, 4	10.62	Dec. 23	0.87	Bridge gauge records.
1880	July 8	18.67	Nov. 25	1.00	High water, bridge gauge records. Low water, Mississippi River Commission discharge party gauge records.
1881	Oct. 27	20.58	Feb. 1, 6 Aug. 31	3.58 4.50	Bridge gauge records.
1882	July 2	18.42	Dec. 12	1.58	
1883	May 20	17.58	Dec. 22	0.33	
1884	Apr. 8	18.50	Mar. 13 Dec. 19	2.17 2.75	
1885	Mar. 16	13.25	Dec. 10, 11	0.75	
1886	May 9	17.08	Dec. 2–5	— 0.67	
1887	Feb. 13	12.00	Dec. 2, 3, 22–24	0.50	
1888	May 17	**21.58**	Dec. 23, 24	0.50	
1889	May 30	8.67	Dec. 6	— 0.25	
1890	July 8	13.50	Jan. 9 Dec. 29	**—1.75** 0.2	
1891	Apr. 23	12.25	Dec. 1	— 1.17	
1892	July 3	20.8	Dec. 21	— 1.4	
1893	May 28	16.8	Dec. 3–5	— 1.6	
1894	June 4–6	12.1	Dec. 31	— 0.8	
1895	June 27	5.2	Dec. 5–6	— 1.5	
1896	June 3, 4	13.3	Jan. 5 Oct. 26–30	— 1.7 0.6	
1897	Apr. 29	20.85	Dec. 6	— 1.4	

MISSISSIPPI RIVER.—GRAFTON, ILL. (233 MILES ABOVE CAIRO.)

[United States Weather Bureau gauge; zero 424.09 feet above the Cairo datum plane.]

1879			Dec. 24	1.14	United States Engineer gauge records.
1880	July 8, 9	19.04	Nov. 27	1.83	
1881	May 5	22.88	Jan. 30 Sept. 2	3.11 3.93	
1882	July 5, 6	23.13	Dec. 14, 15	2.28	
1883	June 25	23.33	Dec. 27	2.43	
1884	Apr. 6, 7	21.08	Dec. 22	3.33	
1885	Apr. 29	17.27	Dec. 16	1.83	
1886	May 15	18.46	Dec. 4	— 0.07	
1887	Feb. 16	13.64	Dec. 28, 29	— 0.07	
1888	May 30	22.39	Dec. 24	0.93	
1889	May 31	14.38	Oct. 14	0.88	
1890	July 2	14.38	Dec. 17	0.40	
1891	Apr. 26	14.93	Feb. 7 Oct. 7	0.07 0.36	
1892	May 18	**25.73**			
1894	May 12	14.3	Aug. 29, Sept. 4	0.8	United States Weather Bureau gauge records.
1895	Dec. 22	14.4	Dec. 9	**—0.9**	
1896	May 30	18.1	Oct. 31	2.6	
1897	May 2	23.2	Dec. 9, 10	0.1	
1898	May 23	18.1			

MISSISSIPPI RIVER.—ST. LOUIS, MO. (191 MILES ABOVE CAIRO.)

[United States Engineer gauge; zero 400.23 feet above the Cairo datum plane.]

1785	Apr. —	?42.0			United States Signal Service, on the authority of Dr. Engleman.
1826		33.81			Major Merrill, Chief of Engineers' Report, 1872, p. 429.
1828		36.4			H. and A. Report, p. 171. (United States Signal Service, on the authority of Dr. Engleman, makes this 33.6.)
1838	May 28	27.0			United States Signal Service, on the authority of Dr. Engleman.
1843	May 2	27.2			Do.

TABLE NO. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—**Continued.**

MISSISSIPPI RIVER.—ST. LOUIS, MO. (191 MILES ABOVE CAIRO.)—**Continued.**

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1844	June 28	**41.39**			Major Merrill, Chief of Engineers' Report, 1872, p. 429, and St. Louis City Hall records.
1845	June 27	32.4			United States Signal Service, on the authority of Dr. Engleman.
1846	May 10	25.0			Do.
1849	Mar. 10	27.4			Do.
1851	June 10	36.61			H. and A. Report, p. 171. (United States Signal Service, on the authority of Dr. Engleman, makes this 27.0.)
1852	May 20	28.0			United States Signal Service, on the authority of Dr. Engleman.
1853	May 7	30.0			Do.
1855		37.1			Major Merrill, Chief of Engineers' Report, 1872, p. 429.
1856	May 9	27.4			United States Signal Service, on the authority of Dr. Engleman.
1858	June 15	37.21			H. and A. Report, p. 171.
1860			Dec. 27	0.6	St. Louis City gauge records by adding 33.8 feet, on the authority of Major Merrill, Chief of Engineers' Report 1872, p. 429.
1861	May 15	25.47	Jan. 1 Dec. 9	1.33 4.13	
1862	Apr. 26	31.45	Jan. 8 Dec. 13	3.48 4.64	
1863	Mar. 4, 9	18.02	Dec. 21	0.00	
1864	May 14	20.33	Jan. 2 Oct. 28–Nov. 3	1.22 2.35	
1865	July 28	26.81	Feb. 1, 2 Dec. 15	1.19 5.12	
1866	Apr. 25	26.77	Dec. 21	5.79	
1867	May 1	28.21	Dec. 19	1.27	
1868	May 14, 15	24.19	Jan. 14 Dec. 30, 31	0.85 4.65	
1869	July 24	29.31	Jan. 2 Dec. 31	5.61 8.35	
1870	Apr. 16	26.21	Dec. 24	5.26	
1871	Mar. 17	21.82	Dec. 21	2.84	
1872	June 12–14	23.00	Dec. 4	2.50	
1873	Apr. 11	25.45	Nov. 30–Dec. 2	4.67	
1874	June 19, 20	18.40	Dec. 31	2.80	United States Engineer gauge records.
1875	Aug. 3	29.80	Jan. 3 Dec. 4, 5	2.30 4.00	
1876	May 10	32.00	Feb. 7	5.00	
1877	June 14	26.60	Oct. 4	6.85	
1878	June 15	25.75	Dec. 25	5.65	
1879	July 3	21.15	Dec. 26	3.50	
1880	July 12	25.50	Nov. 29	2.80	
1881	May 6	33.65	Feb. 5, 6 Sept. 3	7.55 8.60	
1882	July 5	32.39	Dec. 18	2.85	
1883	June 26	34.80	Jan. 12 Dec. 29	4.45 4.55	
1884	Apr. 9, 10	28.10	Jan. 5 Dec. 25	3.15 4.10	
1885	June 17	27.10	Dec. 15	2.10	
1886	May 13	27.00	Dec. 5	1.45	
1887	Apr. 3	20.70	Dec. 27	1.02	
1888	June 4	29.35	Dec. 25	3.25	
1889	June 1	24.65	Feb. 26 Oct. 20, 30, 31	2.50 3.70	
1890	July 1	20.60	Dec. 17	2.95	
1891	July 4	23.78	Dec. 3	2.60	
1892	May 19	35.95	Dec. 24	1.10	
1893	May 3	31.60	Dec. 8, 9	0.10	
1894	May 11	23.70	Feb. 3 Dec. 31	0.20 1.00	
1895	Dec. 22	23.40	Jan. 27 Dec. 9	**−0.60** −0.15	
1896	May 26, 28	27.70	Dec. 11	3.80	
1897	May 2	30.95	Dec. 24	−0.40	
1898	May 23	27.20			

TABLE No. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

MISSISSIPPI RIVER.—CHESTER, ILL. (116 MILES ABOVE CAIRO.)

[United States Weather Bureau gauge; zero 361.30 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1891	June 11	18.2	Dec. 5-7, 12-13	0.9	United States Weather Bureau gauge records.
1892	May 21	**31.2**	Jan. 15 Dec. 6, 7, and 22	—1.8 2.7	
1893	May 4	28.4			
1894	May 12	18.0	Dec. 31	0.0	
1895	Dec. 25	19.4	Dec. 13	—1.5	High water, United States Weather Bureau. Low water estimated.
1896	May 29	24.8	Dec. 12	1.8	United States Weather Bureau gauge records.
1897	May 3	26.1	Dec. 24-25	**—1.9**	
1598	May 24	22.2			

MISSISSIPPI RIVER.—GRAND TOWER, ILL. (79 MILES ABOVE CAIRO.)

[United States Weather Bureau gauge; zero 344.65 feet above the Cairo datum plane.]

1885	June 24	23.8	Dec. 18-20	2.5	United States Signal Service gauge records.
1886	May 15	23.5	Dec. 8	**—0.1**	
1887	Mar. 20	17.20	Dec. 31	0.20	
1888	June 4, 5	**24.50**	Jan. 1 Dec. 25, 26	0.00 3.00	
1889	June 2	20.50	Oct. 18-22	2.10	
1890	Jan. 16, Apr. 30	17.00	Dec. 19-21	1.90	
1891					Discontinued Jan. 31, 1891.

MISSISSIPPI RIVER.—CAPE GIRARDEAU, MO. (54 MILES ABOVE CAIRO.)

[Mississippi River Commission gauge; zero 324.97 feet above the Cairo datum plane.]

1896	May 29	28.9	Nov. 2, Dec. 12-14	5.8	Mississippi River Commission gauge records.
1897	Apr. 12, 13	**31,6**	Dec. 26, 27	**1.0**	
1898	May 24	27.1			

MISSISSIPPI RIVER.—GRAYS POINT, MO. (48 MILES ABOVE CAIRO.)

[Mississippi River Commission gauge; zero 321.28 feet above the Cairo datum plane.]

1879	July 5	23.90	Dec. 26	6.00	Rob. Berry, gauge keeper.
1880	July 10	25.86	Dec. 31	**0.95**	United States Engineer gauge records.
1881	May 8	32.96	Jan. 1 Aug. 28	1.46 9.31	
1882	Feb. 24	32.16	Dec. 19	3.16	
1883	June 27-28	34.31	Jan. 23-24 Dec. 29	3.41 6.66	High water, United States Engineer gauge records. Low water, Mississippi River Commission gauge records.
1884	Apr. 10-11	28.15	Dec. 27	3.60	Mississippi River Commission gauge records.
1885	June 24	27.35	Dec. 19	5.58	
1886	May 15	27.45	Dec. 8	3.60	
1887	Mar. 10	22.65	Dec. 31	1.32	
1888	June 4-5	28.56	Jan. 1	1.00	
1889	June 2	25.80	Dec. 26-27 Oct. 19-24	5.41 5.25	United States Engineer gauge records.
1890	Apr. 6	25.35	Dec. 19-20	4.90	
1891	Apr. 26	23.10	Dec. 6	4.75	
1892	May 22	**35.00**	Dec. 29-30	1.85	Mississippi River Commission gauge records.
1893	May 4-5	32.50	Jan. 1 Dec. 9	2.35 3.10	
1894	May 13	22.80	Dec. 31	4.00	
1895	Dec. 25	23.70	Jan. 7-8 Dec. 11	2.35 3.15	
1896	May 29	27.90			For later years see Cape Girardeau.

TABLE No. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

OHIO RIVER.—CAIRO, ILL.

[United States Engineer gauge; zero 290.84 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1858	June 21, 22	49.56			H. and A. Report, p. 581, corrected by adding 9.16.
1859	May 7	†46.8	Nov. 7–17	5.4	United States Signal Service gauge records.
1860	Jan. 23	†37.8	Oct. 12	3.6	
1861	Apr. 24, 25	43.2			
1862	May 2	50.76			Maj. H. L. Abbot, Chief of Engineers' Report 1875, p. 568.
1864	do	†33.5			United States Signal Service gauge records.
1865	Mar. 18, 19	47.9	Dec. 4	6.5	
1866	May 1	42.6	Aug. 17, 18	9.8	
1867	Mar. 20–22	51.0	Dec. 14	2.7	High water, United States Signal Service gauge records. Low water, Chief of Engineers' Report, 1881, p. 1440.
1868	May 19	45.6			United States Signal Service gauge records.
1871			Dec. 24	**−1.0**	Major Merrill, Chief of Engineers' Report, 1872, p. 429.
1872	Apr. 19, 20	39.20	Dec. 6	1.00	United States Engineer gauge records.
1873	Feb. 26	41.55	Oct. 15–17	2.60	
1874	Apr. 26	47.37	Nov. 13	3.00	
1875	Aug. 8	45.12	Jan. 26 Nov. 4	5.30 5.82	
1876	Apr. 6, 7	46.38	Dec. 31	0.10	
1877	Apr. 15	40.52	Jan. 1 Oct. 12, 13	1.00 3.40	
1878	Apr. 29	37.04	Oct. 22	5.92	
1879	Dec. 31	36.50	Oct. 10	2.68	
1880	Mar. 22	44.60	Nov. 29, 30	5.70	
1881	Apr. 20	45.80	Sept. 9, 10	5.40	
1882	Feb. 26	51.87	Dec. 19	7.30	
1883	Feb. 27	**52.17**	Sept. 30	4.70	
1884	Feb. 22–24	51.79	Sept. 23	7.10	
1885	Jan. 26	39.00	Oct. 20	8.30	
1886	Apr. 19	51.02	Nov. 11, 12	3.80	
1887	Mar. 9–10	48.50	Dec. 31	2.00	
1888	Apr. 4, 5	45.35	Jan. 1 Oct. 15	1.80 5.09	
1889	June 24	34.53	Oct. 23	2.54	
1890	Mar. 12	48.80	Dec. 25	8.70	
1891	Mar. 4–6	46.21	Oct. 10, 11	2.07	
1892	Apr. 28	48.29	Oct. 29	3.85	
1893	May 9	49.33	Sept. 5	4.62	
1894	Feb. 16	37.00	Nov. 3	2.81	
1895	Jan. 21, 22	33.00	Nov. 6	1.10	
1896	Apr. 13	39.20	Sept. 16	5.58	
1897	Mar. 25, 26	51.62	Oct. 22–28	2.50	
1898	Apr. 6	49.78			

MISSISSIPPI RIVER.—BELMONT, MO. (21 MILES BELOW CAIRO.)

[Mississippi River Commission gauge; zero 286.85 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
1880		39.47			High-water mark at Columbus, Ky.
1882	Feb. 26	45.10			Mississippi River Commission gauge record, Columbus, Ky.
1883	Feb. 26	**45.58**	Sept. 30	4.90	High-water marks at Columbus, Ky.
1884	Feb. 23, 24	45.37	Dec. 10	7.10	Low waters, Mississippi River Commission gauge record.
1885	Jan. 26	36.40	Oct. 20	8.21	Mississippi River Commission gauge record.
1886	Apr. 19	44.88	Nov. 11–13	4.70	
1887	Mar. 10, 11	43.30	Dec. 31	1.72	
1888	Apr. 6	41.35	Jan. 1 Oct. 14–18	1.68 5.60	
1889	June 24	31.71	Oct. 23	3.15	
1890	Apr. 6	43.33	Dec. 24–25	9.00	
1891	Mar. 6–7	41.30	Nov. 7	1.55	
1892	Apr. 28	43.14	Oct. 28–29	2.68	
1893	May 8–10	43.80	Sept. 5–6	3.95	
1894	Feb. 16	34.15	Nov. 3	0.79	
1895	Jan. 22	30.40	Nov. 6–8	**0.05**	
1896	Apr. 13	35.85	Sept. 16	5.50	
1897	March 28–30	45.08	Oct. 22, 23	1.87	
1898	Apr. 6	43.95			

TABLE No. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

MISSISSIPPI RIVER.—MORRISSON LANDING, MO. (69 MILES BELOW CAIRO.)

[Mississippi River Commission gauge; zero 275.80 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1879	....	....	Nov. 11-13	**—0.17**	Mississippi River Commission gauge record.
1880	Mar. 24-25	34.70	Nov. 29-30	2.20	
1882	....	....	Dec. 19-20........	3.70	
1883	....	....	Oct. 1	1.72	
1884	Feb. 23-25.........	**41.50**	Dec. 10............	3.90	
1885	Jan. 26............	31.45	Oct. 20-21	5.25	
1886	Apr. 20	40.40	Nov. 13	1.92	
1887	Mar. 11-12	37.78	Dec. 31............	0.30	
1888	Apr. 6	36.00	Jan. 2............. Oct. 17-18	0.10 3.50	
1889	June 24-25........	27.50	Oct. 23-25	1.80	
1890	Mar. 15	38.15	Dec. 26............	7.50	
1891	Mar. 7-8	36.40	Nov. 7-8	2.50	
1892	Apr. 29	37.68	Oct. 28-29	3.40	
1893	May 10, 11	38.70	Jan. 16............ Sept. 6............	4.0 4.4	For later years see New Madrid Mo.

MISSISSIPPI RIVER.—NEW MADRID, MO. (70 MILES BELOW CAIRO.)

[Mississippi River Commission gauge; zero 275.72 feet above the Cairo datum plane.]

1893	May 10............	38.11	Jan. 22............ Sept. 6	4.12 4.36	Mississippi River Commission gauge record.
1894	Feb. 16-18.........	29.46	Nov. 2	1.67	
1895	Jan. 22............	25.97	Nov. 6-8	**0.55**	
1896	Apr. 14	30.87	Sept. 17	4.95	
1897	Mar. 29............	**40.27**	Oct. 26	1.83	
1898	Apr. 7-8	38.36			

MISSISSIPPI RIVER.—COTTONWOOD POINT, MO. (123 MILES BELOW CAIRO.)

[Mississippi River Commission gauge; zero 250.67 feet above the Cairo datum plane.]

1880	Mar. 23-26.........	35.50	Nov. 30, Dec. 1....	2.10	Mississippi River Commission gauge record.
1881	Apr. 23-25	35.20	Jan. 8-9........... Sept. 9-11	1.60 1.80	
1882	Feb. 28............	37.53	Dec. 19-20.........	3.60	
1883	Feb. 28............	37.85	Oct. 1, 2	1.00	
1884	Feb. 23-27.........	37.45	Dec. 10-11.........	2.70	
1885	Jan. 26-27.........	31.90	....	....	
1886	Apr. 21	37.09	....	....	High-water correspondent.
1889	June 25............	27.60	Oct. 24-25	—0.35	Mississippi River Commission gauge record.
1890	Mar. 15-16	36.40	Dec. 26............	5.10	
1891	Mar. 8	35.90	Nov. 7-8...........	—0.40	
1892	Apr. 30............	36.45	Oct. 29-31	0.40	
1893	May 12-13..........	36.55	Jan. 17 .... Sept. 6-7	1.10 1.80	
1894	Feb. 17-18.	30.55	Nov. 2-7	—1.45	
1895	Jan. 23	26.4	Nov. 5-8	**—3.35**	
1896	Apr. 14............	31.2	Sept. 17-18	2.2	
1897	Mar. 21-23	**39.35**	Oct. 24, 26-29	?—1.5	
1898	Apr. 8-10..........	38.65			

MISSISSIPPI RIVER.—FULTON, TENN. (175 MILES BELOW CAIRO.)

[Mississippi River Commission gauge; zero 228.55 feet above the Cairo datum plane.]

1879	....	....	Nov. 13-15	†2.10	Mississippi River Commission gauge record.
1880	Mar. 26............	34.18	Nov. 1	4.65	
1881	Apr. 26............	34.29	....	....	
1882	Mar. 1-2...........	36.69	Dec. 20............	6.64	
1883	....	†36.3	Oct. 1-2	4.68	
1884	Feb. 24............	35.70	Dec. 11............	5.48	
1885	Jan. 28	29.92	Oct. 21-22	6.25	
1886	Apr. 22	35.37	Nov. 14	3.86	
1887	Mar. 12	34.61	Nov. 22	2.22	
1888	Apr. 10............	33.61	Jan. 3 .... Oct 17	1.60 5.18	
1889	June 26............	25.68	Oct. 23	2.30	
1890	Mar. 22	34.90	Dec. 27-28.........	7.67	

TABLE No. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

MISSISSIPPI RIVER.—FULTON, TENN. (175 MILES BELOW CAIRO.)—Continued.

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1891	Mar. 13–14	33.90	Nov. 7	2.65	Mississippi River Commission gauge record.
1892	Apr. 30	34.27	Oct. 30, Nov. 1	4.72	
1893	May 15	34.63	Jan. 23 Dec. 2	4.90 5.48	
1894	Feb. 18–19	27.75	Nov. 5–7	1.74	
1895	Jan. 24	23.08	Nov. 7–8	**0.16**	
1896	Apr. 15	28.07	Sept. 19	4.70	
1897	Mar. 23	37.47	Oct. 28–30	2.78	
1898	Apr. 10	**38.30**			

MISSISSIPPI RIVER.—MEMPHIS, TENN. (230 MILES BELOW CAIRO.)

[United States Engineer gauge; zero 203.97 feet above the Cairo datum plane.]

1828		32.86			H. and A. Report, p. 171.
1844	July —	33.16			
1848			Oct. 29, Nov. 2, 3	1.36	H. and A. Report, p. 515. Deducting 1.14. Major Willard's MS. 1891.
1849	Feb. 8–16	30.86	Sept. 23	3.46	H. and A. Report, p. 516. Deducting 1.14. Major Willard's MS. 1891.
1850	May 14–21	33.56	Nov. 3, 4	2.46	H. and A. Report, p. 517. Deducting 1.14. Major Willard's MS. 1891.
1851	Mar. 11	33.16	Dec. 27–31	3.46	H. and A. Report, p. 518. Deducting 1.14. Major Willard's MS. 1891.
1852	Apr. 21–23	32.96			H. and A. Report, p. 522. Deducting 1.14. Major Willard's MS. 1891.
1858	June 23	34.16	Oct. 24–27	2.86	H. and A. Report, p. 532. Deducting 1.14. Major Willard's MS. 1891.
1859	May 12, 13	34.06			Major Willard's MS. 1891.
1862		34.78			
1865		33.68			
1867	Mar. 26	? 33.95			Major Benyaurd, Chief of Engineers' Report, 1881, p. 1444.
1871			Dec. 29	—0.92	United States Engineer gauge records.
1872	Apr. 24	31.50	Dec. 25	—0.95	
1873	Mar. 3	32.50	Oct. 30	1.00	
1874	May 2	34.00	Nov. 16	1.40	
1875	Aug. 15–17	33.05	Jan. 27 Nov. 11	3.20 4.10	
1876	Apr 8, 9	34.08	Dec. 30	1.20	
1877	Apr. 29	32.05	Jan. 2 Oct. 18	0.75 2.45	
1878	May 2	29.10	Oct. 24, Nov. 3	2.90	
1879	Jan. 29	28.10	Oct. 9–12, Nov. 11	1.05	
1880	Mar. 24–29	33.40	Oct. 31	2.60	
1881	Apr. 27, 28	33.30	Sept. 11, 12	2.10	
1882	Mar. 6, 9	35.15	Dec. 21	3.50	
1883	Mar. 6–8	34.75	Oct. 2	1.90	
1884	Mar. 1–3	34.15	Dec. 11, 12	3.10	
1885	Jan. 28	29.25	Oct. 21–23	4.15	
1886	Apr. 28	34.80	Nov. 14–16	2.50	
1887	Mar. 9, 10	35.30	Nov. 20–24	1.20	
1888	Apr. 11, 12	34.20	Jan. 4 Oct. 18, 19	0.80 4.00	
1889	June 26, 27	26.60	Oct. 24–26	1.60	
1890	Mar. 23, 24, Apr. 4, 5	35.60	Dec. 26, 27	7.20	
1891	Mar. 10	34.90	Nov. 8, 9	1.00	
1892	May 2, 3	34.60	Oct. 30, 31	1.60	
1893	May 15, 16	35.20	Jan. 24 Sept. 7, 8	1.80 2.55	
1894	Feb. 19, 20	29.00	Nov. 6–8	—1.40	
1895	Jan. 23, 24	24.05	Nov. 6–9	**—2.65**	
1896	Apr. 15, 16	29.40	Sept. 19, 20	1.80	
1897	Mar. 20	**37.66**	Oct. 27–31	0.25	
1898	Apr. 10	37.59			

TABLE NO. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

MISSISSIPPI RIVER.—MHOON LANDING, MISS. (277 MILES BELOW CAIRO.)

[Mississippi River Commission gauge; zero 181.48 feet above Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1880	......	36.10	......	......	High-water mark Mississippi River Commission levels.
1882	Mar. 8-9	39.80	Dec. 22	5.90	Mississippi River Commission gauge records.
1883	Mar. 7, 8	40.20	Oct. 1-2	2.40	
1884	Mar. 5-6	? 38.90	Dec. 12	2.60	
1885	Jan. 28-29	33.80	......	......	
1889	June 27	27.70	Oct. 26-31	2.20	
1890	Mar. 28-Apr. 2	38.50	Aug. 26-27	8.10	
1891	Mar. 10-13	? 35.4	Nov. 7-15	1.60	
1892	May 8-11	36.30	Nov. 1-2	2.2	
1893	May 24-25	37.90	Jan. 23-25 Oct. 23	—2.6 —1.90	
1894	Feb. 20-21	30.80	Nov. 6-10	—7.24	
1895	Mar. 29-30	? 25.40	Nov. 6-11	**—7.80** ?	
1896	Apr. 16-17	31.70	Sept. 19-21	—2.30	
1897	Apr. 4	**41.60**	Oct. 23-Nov. 1	—7.40	
1898	Apr. 14-16	39.06			

MISSISSIPPI RIVER.—HELENA, ARK. (306 MILES BELOW CAIRO.)

[United States Engineer gauge; zero, 161.98 feet above the Cairo datum plane.]

1828	......	43.11	......	......	H. and A. Report, p. 171. Corrected by deducting 0.39 foot. Major Benyaurd, Chief of Engineers' Report, 1876, p. 606.
1844	......	42.21			
1849	......	42.81			
1850	May 1	42.81			
1851	......	39.81			
1858	July 2-6	44.61	......	......	H. and A. Report, p. 533. Corrected by deducting 0.39 foot. Major Benyaurd. Chief of Engineers' Report, 1876, p. 606.
1859	Mar. 22	43.61	......	......	H. and A. Report, p. 171. Corrected by deducting 0.39 foot. Major Benyaurd. Chief of Engineers' Report, 1876, p. 606.
1862	......	46.40	......	......	Major Merrill, Chief of Engineers' Report, 1872, p. 432. Corrected by adding 2.20 feet. Major Benyaurd, Chief of Engineers' Report, 1876, p. 606.
1865	......	44.40	......	......	Major Abbot, Chief of Engineers' Report, 1869, p. 336, and 1875, p. 568.
1867	......	45.82	......	......	Major Merrill, Chief of Engineers' Report, 1872, p. 432. Corrected by adding 2.20 feet. Major Benyaurd, Chief of Engineers' Report, 1876, p. 606.
1871	......	......	Dec. 29	1.15	United States Engineer gauge records.
1872	Apr. 26	39.03	Dec. 26	0.00	
1873	Mar. 6	40.00	Oct. 17, 19, 20, 22	4.00	
1874	May 11	45.82	Nov. 16	3.70	
1875	Apr. 12-14	42.40	Jan. 28 Nov. 9	6.50 7.60	
1876	Apr. 18, 19	44.85	Dec. 31	3.00	
1877	Apr. 30-May 1	41.80	Jan. 4 Oct. 17	1.70 5.00	
1878	May 2, 4	38.75	Oct. 25	†7.25	
1879	Jan. 31	37.25	Nov. 14	†4.10	
1880	Mar. 31	43.70	Nov. 8	8.10	
1881	May 14	43.74	Sept. 15	6.25	
1882	Mar. 9	47.20	Dec. 22, 23	8.60	
1883	Mar. 8, 9	46.90	Oct. 1, 2	6.40	
1884	Mar. 6	47.00	Dec. 13	7.25	
1885	Jan. 30	40.70	Oct. 23	8.00	
1886	Apr. 30	48.10	Nov. 16	3.00	
1887	Mar. 21, 22	46.40	Nov. 23	0.25	
1888	Apr. 14, 15	42.80	Jan. 5 Oct. 19	— 0.20 4.60	
1889	June 28	34.10	Oct. 26	1.60	
1890	Mar. 29, 30	47.72	Aug. 27	10.02	
1891	Mar. 27, 28	44.70	Nov. 8	0.85	
1892	May 11	45.73	Oct. 31	1.18	
1893	May 25	47.92	Sept. 8	2.65	

Table No. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

MISSISSIPPI RIVER.—HELENA, ARK. (306 MILES BELOW CAIRO.)—Continued.

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1894	Feb. 21	38.07	Nov. 8	— 2.23	United States Engineer gauge records.
1895	Mar. 30, 31	31.30	Nov. 8, 9	**—3.00**	
1896	Apr. 17	38.42	Sept. 21	4.00	
1897	Apr. 4	**51.75**	Oct. 29	— 0.80	
1898	Apr. 17	49.11			

MISSISSIPPI RIVER.—SUNFLOWER LANDING, MISS. (358 MILES BELOW CAIRO.)

[Mississippi River Commission gauge; zero, 147.08 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
1880		40.61			High-water mark, Mississippi River Commission levels.
1881		39.75			
1882		41.65	Dec. 2	7.20	Do. Low water, Mississippi River Commission gauge records.
1883	Mar. 10–11	41.75	Sept. 28	5.00	Mississippi River Commission gauge records.
1889	June 29	33.50			
1890	Mar. 30–Apr. 1	42.90	Aug. 27	9.10	
1891	Mar. 28–Apr. 1	40.90	Nov. 9, 14	2.10	
1892	May 11–13, June 1	41.70	Nov. 1	3.2	
1893	May 28	43.00	Sept. 8–9	4.50	
1894	Feb. 22	37.30	Nov. 6–8	— 0.34	
1895	Mar. 31	31.10	Nov. 12–14	**—1.50**	
1896	Apr. 17–18	38.20	Sept. 21–22	4.60	
1897	Mar. 27	**47.17**	Oct. 26–31	— 0.1	
1898	Apr. 17–19	46.00			

MISSISSIPPI RIVER.—MOUTH OF WHITE RIVER, ARK. (393 MILES BELOW CAIRO.)

[United States Engineer gauge; zero, 128.73 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
1862	Apr. 20	48.2			Major Abbot, Chief of Engineers' Report, 1869, p. 336; Major Benyaurd, Chief of Engineers' Report, 1881, p. 1445.
1867	Mar. 30	46.8			Major Merrill, Chief of Engineers' Report, 1872, p. 432. Corrected by adding 3.2 feet. Major Benyaurd, Chief of Engineers' Report, 1876, p. 611.
1871			Dec. —	1.87	
1872	Apr. 30–May 1	40.20	Dec. 28	**0.00**	United States Engineer gauge records.
1873	Apr. 25, 26	42.90			
1874	Apr. 28	46.60	Nov. 16	2.70	High water, Major Benyaurd MS. and Chief of Engineers' Report, 1876, p. 611; low water, United States Engineer gauge records.
1875	Apr. 16–17	45.00	Jan. 28 Nov. 9	6.80 9.05	United States Engineer gauge records.
1876	Apr. 8–15	46.70	Dec. 26	2.90	
1877	May 5–6	44.60	Jan. 8 Oct. 16–17	2.20 4.50	
1879			Oct. 14–15	2.40	
1880	Mar. 23–25	46.55	Nov. 4	7.00	
1881	May 15–18	45.70	Sept. 14	5.50	
1882	Feb. 28	48.40	Dec. 23–24	9.70	
1883	Mar. 9–12	48.00	Oct. 3	6.80	
1884	Mar. 7–8	47.90	Dec. 13	9.00	
1885	Jan. 23–25	43.60	Oct. 24	10.00	
1886	May 4	48.20	Nov. 15–16	5.90	
1887	Mar. 23–25	47.75	Nov. 23–24	3.50	
1888	Apr. 20	45.55	Jan. 5–6 Oct. 20	4.50 7.90	
1889	June 29	37.70	Oct. 27–29	5.10	
1890	Mar. 31	50.40	Aug. 14–16	13.20	
1891	Apr. 5	47.72	Nov. 14–15	4.78	
1892	June 1	49.27	Oct. 27	6.50	
1893	May 29	49.48	Oct. 26	7.80	
1894	Feb. 23	42.12	Nov. 7–8	2.65	
1895	Apr. 1	34.35	Nov. 8–10	1.28	
1896	Apr. 18	41.72	Sept. 22–25	7.90	
1897	Mar. 29	**52.42**	Oct. 30	2.81	
1898	Apr. 19	51.05			

TABLE NO. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

MISSISSIPPI RIVER.—ARKANSAS CITY, ARK. (438 MILES BELOW CAIRO.)

[Mississippi River Commission gauge; zero, 116.44 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1880	May 20–27	45.10	Nov. 4	5.90	Mississippi River Commission gauge records.
1881	May 16–18	44.80	Jan. 14 Sept. 14	1.80 3.40	
1882	Feb. 28	47.10	Dec. 23, 24	7.50	
1883	Mar. 11	46.35	Oct. 3, 4	4.20	
1884	Mar. 7–9	46.50	Sept. 29	7.30	
1885	May 7–9	42.60	Oct. 24, 25	7.70	
1886	May 4, 5	46.90	Nov. 16–18	3.00	
1887	Mar. 25–27	46.65	Nov. 24, 25	0.30	
1888	Apr. 21, 22	45.38	Jan. 6, 7 Oct. 20, 21	1.70 4.80	
1889	June 30, July 1	36.30	Oct. 28, 29	2.80	
1890	Mar. 27	49.50	Aug. 15–17	10.50	
1891	Apr. 3–7	48.20	Nov. 10–17	0.5	
1892	June 1	50.00	Oct. 28	2.10	
1893	May 29	50.30	Oct. 26	3.40	
1894	Feb. 24–25, Mar. 29–30.	40.5	Nov. 8	— 2.36	
1895	Apr. 1, 2	32.5	Nov. 9, 10	**—3.6**	
1896	Apr. 19	40.00	Sept. 22, 23	3.1	
1897	Mar. 29	**51.9**	Oct. 27–Nov. 1	— 2.8	
1898	Apr. 19–21	51.13	....	....	

MISSISSIPPI RIVER.—GREENVILLE, MISS. (478 MILES BELOW CAIRO.)

[Mississippi River Commission gauge; zero, 108 feet above the Cairo datum plane.]

1844	....	42.16	....	....	High-water mark, Mississippi River Commission levels.
1858	....	43.00	....	....	
1867	....	39.92	....	....	
1882	Feb. 27	41.68	Dec. 23, 24	7.35	Mississippi River Commission gauge records.
1883	Mar. 9–13	40.40	Oct. 4	5.60	
1884	Mar. 7, 8	41.10	Dec. 14	7.80	
1885	May 7, 8	38.05	Oct. 25	8.30	
1886	May 6	41.20	Nov. 15–17	4.20	
1887	Mar. 21–26	40.80	Nov. 22–24	1.85	
1888	Apr. 21–23	40.55	Jan. 6. 7 Oct. 21	2.60 5.40	
1889	July 1	31.85	Oct. 28, 29	3.15	
1890	Mar. 17, 18	43.45	Aug. 15–17	10.00	
1891	Apr. 2, 3	43.25	Nov. 13–16	2.20	
1892	June 1	44.28	Oct. 27, 28	2.80	
1893	May 29	44.30	Oct. 26, 27, Nov. 17–19, 30–Dec. 2.	3.40	
1894	Feb. 25	35.40	Nov. 8. 9	— 1.01	
1895	Apr. 1	27.75	Nov. 10, 11	**—2.55**	
1896	Apr. 19	34.60	Sept. 23	2.90	
1897	Mar. 29	**46.75**	Oct. 30	— 1.1	
1898	Apr. 21	46.16	....	....	

MISSISSIPPI RIVER.—LAKE PROVIDENCE, LA. (542 MILES BELOW CAIRO.)

[United States Engineer gauge; zero, 89.62 feet above the Cairo datum plane.]

1862	....	40.87	....	....	Major Merrill, Chief of Engineers' Report, 1872., p. 432.
1867	....	39.99	....	....	Major Merrill, Chief of Engineers' Report, 1872, p. 432. (A high-water mark, levels of Mississippi River Commission, makes this 39.31.)
1871	....	....	Dec. 31	— 2.60	United States Engineer gauge records.
1872	May 1	35.15	Dec. 29	— 3.85	
1873	May 28	36.12	Nov. 4	0.91	
1874	Mar. 21–23	37.37	Nov. 16	0.95	
1875	Apr. 19, 20	37.29	Nov. 12	5.90	
1876	Apr. 12–14	37.96	Dec. 31	1.25	
1877	May 6, 7	35.82	Jan. 1–3 Oct. 17, 18	1.25 3.20	
1878	Mar. 22–24	35.80	Oct. 27, 28, Nov. 5, 6.	3.75	
1879	Feb. 14–16	36.00	Oct. 16, 17	0.55	
1880	Apr. 8	38.05	Nov. 8	5.20	

TABLE No. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

MISSISSIPPI RIVER.—LAKE PROVIDENCE, LA. (543 MILES BELOW CAIRO.)—Continued.

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1881	Mar. 11	36.17	Sept. 14–19	3.00	United States Engineer gauge records.
1882	Mar. 20	38.32	Dec. 25	5.90	
1883	Mar. 11–14	36.47	Oct. 2	4.20	
1884	Mar. 23, 24	38.40	Dec. 15	5.55	
1885	May 10, 11	35.55	Oct. 26	6.40	
1886	May 7	37.91	Nov. 19	2.65	
1887	Mar. 26	38.01	Nov. 22–24	1.52	
1888	Apr. 24, 25	38.10	Jan. 7, 8 Oct. 21–23	2.08 5.50	
1889	July 1, 2	29.40	Oct. 29, 30	2.80	
1890	Mar. 15	41.05	Aug. 17	3.50	
1891	Apr. 1–4	41.00	Nov. 13	0.60	
1892	June 2	41.9	Oct. 28, 29	0.70	
1893	May 15–17	41.85	Nov. 19–Dec. 2	0.75	
1894	Feb. 25, 26	34.40	Nov. 9, 11, 12	− 4.25	
1895	Apr. 2, 3	25.90	Nov. 17	**−5.30**	
1896	Apr. 20, 21	33.25	Sept. 23–26	1.00	
1897	Mar. 30	**44.54**	Nov. 2–6	− 3.70	
1898	Apr. 23	44.85			

MISSISSIPPI RIVER.—VICKSBURG, MISS. (599 MILES BELOW CAIRO.)

[United States Engineer gauge; zero 66.04 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
1828		46.38			H. and A. Report, p. 172. Major Willard, MS., 1891.
1844	June 28	46.18			
1849	Apr. 26	46.38			
1850	June 4	47.08			Major Willard, MS., 1891.
1855				− 1.32	
1858	June 26	46.98	Oct. 31	7.28	High water, Major Willard, MS., 1891. Low water, H. and A. Report, p. 534, corrected by subtracting 1.32, authority of Major Willard, MS., 1891.
1859	Apr. 21	48.28			Major Willard, MS., 1891.
1862	Apr. 27	51.10			Major Merrill, Chief of Engineers' Report, 1872, p. 433. Major Willard, MS., 1891.
1865		46.43?			Major Willard, MS., 1891. (Major Abbot, Chief of Engineers' Report, 1869, p. 337 gives this as 2.3 less than 1862.)
1867		49.02?			Major Willard, MS., 1891.
1871			Dec. 31	− 0.38	United States Engineer gauge records.
1872	May 2, 3	39.50	Dec. 30	− 1.30	
1873	May 29, 30	40.60	Jan. 1 Oct. 23, 24	2.35 2.70	
1874	May 2–5	45.70	Nov. 16, 21	3.15	
1875	Apr. 21	43.00	Nov. 13–15	3.10	
1876	May 10	44.90	Dec. 30, 31	4.05	
1877	May 8–13	41.60	Jan. 6, 7	†2.25	
1878	Mar. 24–27	40.95			
1879	Feb. 17	39.45	Nov. 17	3.8	High water, United States Engineer gauge records. Low water, pilots' log.
1880	Apr. 8, 9	43.15	Oct. 27	7.70	United States Engineer gauge records.
1881	Mar. 10–12	41.85	Sept. 19, 20	3.65	
1882	Mar. 20, 21	48.75	Dec. 26	7.60	
1883	Apr. 7	43.80	Oct. 6	2.90	
1884	Mar. 25	49.00	Dec. 15	4.85	
1885	Feb. 3	42.40	Oct. 26, 27	4.90	
1886	May 7–9	44.15	Nov. 16	0.00	
1887	Mar. 26–31	44.70	Nov. 24, 25	− 3.92	
1888	Apr. 26	44.18	Jan. 7, 8 Oct. 23–25	− 1.35 †2.40	
1889	July 3	34.45	Oct. 30–Nov. 1	− 0.70	
1890	Apr. 24, 25	49.05	Aug. 17–24	9.00	
1891	Apr. 2–4	48.10	Nov. 16–18	− 2.50	
1892	June 2, 3	48.45	Oct. 30	− 1.00	
1893	May 22, 23	48.30	Oct. 28, 29	0.30	
1894	Apr. 2	40.90	Nov. 11–14	− 5.31	
1895	Apr. 3, 4	31.70	Nov. 13, 14	**−6.50**	
1896	Apr. 21	39.00	Sept. 25	1.00	
1897	Apr. 16	**52.48**	Nov. 5–10	− 3.5	
1898	Apr. 24, 25	49.40			

TABLE NO. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

MISSISSIPPI RIVER.—ST. JOSEPH, LA. (648 MILES BELOW CAIRO.)

[Mississippi River Commission gauge; zero 52.74 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1881	Mar. 13	39.20			Mississippi River Commission gauge records.
1882	Mar. 20, 21	44.90	Dec. 26	7.80	
1883	Apr. 7	41.90	Oct. 8, 9	4.20	
1884	Mar. 23	44.98	Dec. 16	3.95	
1885	Feb. 3	38.37			
1889	July 3, 4	†30.60	Oct. 30-Nov. 1	—3.95	
1890	Apr. 23	45.15	Aug. 20-22	5.20	
1891	Apr. 11	43.80	Nov. 15, 16	—4.00	
1892	June 3, 4	44.55	Nov. 6, 7	—2.00	
1893	May 22, 23	44.10	Oct. 29	—1.60	
1894	Apr. 2, 3	36.90	Nov. 10-13	—7.74	
1895	Apr. 4	27.85	Nov. 13	**—9.3**	
1896	Apr. 22	35.15	Sept. 25-27	—2.25	
1897	Apr. 17	**47.85**	Oct. 31	—6.40	
1898	Apr. 25, 26	45.06			

MISSISSIPPI RIVER.—NATCHEZ, MISS. (700 MILES BELOW CAIRO.)

[United States Engineer gauge; zero 36.89 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
1871		43.8		1.2	Chief of Engineers' Report, 1876, p. 613. Major Merrill, Chief of Engineers' Report, 1872, p. 433.
1872	May 2, 4, 5	39.85	Dec. 14-16	0.00	United States Engineer gauge records.
1873	May 30	40.15	Jan. 1 Oct. 24, 25	0.95 2.15	
1874	Apr. 20	45.60	Nov. 17	2.70	
1875	Apr. 25, 26	41.85	Jan. 1 Nov. 15, 16	7.00 7.25	
1876	May 15, 16	43.85	Dec. 31	2.90	
1877	May 30, 31	40.70	Jan. 9 Oct. 17, 18	1.40 5.40	
1878	Mar. 28	39.20	Nov. 8	6.35	
1879	Feb. 17-20	36.80	Oct. 18-22	1.80	
1880	Apr. 16	43.50	Oct. 28	7.30	
1881	Mar. 16, 19	40.80	Sept. 21, 22	4.70	
1882	Mar. 28, 29	47.75	Nov. 6-9	9.70	
1883	Apr. 7-9	44.00	Oct. 6	4.90	
1884	Mar. 24-26	47.40	Oct. 1, 2	7.70	
1885	Feb. 3-5	42.60	Oct. 27	6.50	
1886	May 9-11	43.75	Nov. 8	2.80	
1887	Mar. 30-Apr. 3	44.20	Nov. 25-27	0.75	
1888	Apr. 27-May 1	43.40	Jan. 7 Oct. 23	4.50 5.70	
1889	Mar. 12, 13	34.15	Nov. 3-5	2.70	
1890	Apr. 23	48.60	Aug. 19-21	11.60	
1891	Apr. 11, 12	46.32	Nov. 16, 18-20	3.69	
1892	June 26	48.10	Oct. 29-31	5.00	
1893	May 22-24	46.80	Oct. 29	6.05	
1894	Apr. 3, 4	40.60	Nov. 10-13	1.00	
1895	Apr. 3-5	31.50	Nov. 13-15	**—0.85**	
1896	Apr. 22	38.25	Sept. 25	1.00	
1897	May 2	**49.82**	Nov. 6	3.05	
1898	Apr. 26, 27	47.40			

MISSISSIPPI RIVER.—RED RIVER LANDING, LA. (765 MILES BELOW CAIRO.)

[United States Engineer gauge; zero 23.85 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
1867		46.3			Major Merrill, Chief of Engineers' Report, 1872, p. 434. Corrected by adding 3 feet. Major Benyaurd, Chief of Engineers' Report, 1876, p. 614.
1871		44.5	Dec. 31	†2.00	High water, Major Merrill, as above; low water, United States Engineer gauge records.

TABLE No. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

MISSISSIPPI RIVER.—RED RIVER LANDING, LA. (765 MILES BELOW CAIRO.)—Cont'd.

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1872	May 6	39.42	Dec. 15	0.00	United States Engineer gauge records.
1873	June 12	39.02	Jan. 1 Oct. 25	1.50 2.25	
1874	Apr. 16	47.05	Nov. 22	1.90	
1875	May 3	40.45	Jan. 1 Nov. 13, 14, 16, 17	6.00 6.20	
1876	May 15	45.41	Dec. 30	2.25	
1877	June 1-3	40.55	Jan. 8-10 Oct. 22, 23	0.85 1.95	
1878	....	....	Dec. 1	†5.70	Major Willard, MS.
1879	Feb. 19, 20	35.90	Oct. 24, 25	0.55	United States Engineer gauge records.
1880	Apr. 22-24	44.05	Oct. 26, 27	6.10	
1881	Apr. 6-9	40.10	Sept. 21, 22	3.40	
1882	Mar. 27	48.50	Oct. 18	9.10	
1883	Apr. 9	45.20	Oct. 7, 8	3.95	
1884	Mar. 29-31	47.30	Oct. 1, 2	6.30	
1885	Feb. 5, 6	41.96	Oct. 26	6.70	
1886	May 31	41.94	Nov. 7	!2.70	
1887	Apr. 8	43.00	Nov. 25	0.46	
1888	Apr. 30	41.75	Oct. 23, 24	!3.90	
1889	Mar. 13	34.00	Nov. 4-5	2.40	
1890	Apr. 23	48.67	Aug. 23, 24	8.80	
1891	Apr. 26-May 4	45.48	Nov. 12, 13	0.90	
1892	June 27	48.87	Oct. 31	2.12	
1893	June 25-27	47.72	Oct. 28-31	4.10	
1894	Apr. 5, 6	39.50	Nov. 12	— 0.25	
1895	Apr. 4-6	31.22	Nov. 14	**—0.60**	
1896	Apr. 22, 23	37.40	Sept. 25, 29	3.75	
1897	May 14, 15	**50.20**	Nov. 3, 4, 6	0.35	
1898	Apr. 28-30	44.30	....	....	

MISSISSIPPI RIVER.—BAYOU SARA, LA. (800 MILES BELOW CAIRO.)

[Mississippi River Commission gauge; zero 23.95 feet above the Cairo datum plane.]

Year.	Highest. Day.	Gauge reading.	Lowest. Day.	Gauge reading.	Remarks.
1889	Mar. 13, 14	28.00	Nov. 3-5	—2.10	Mississippi River Commission gauge records.
1890	Apr. 21	41.20	Aug. 30-Sept. 1	4.00	
1891	Apr. 29-May 6	38.80	Nov. 10-15	!—1.8	
1892	June 28	42.25	Oct. 31	—0.75	
1893	June 24, 25	41.50	Oct. 25	0.22	
1894	Apr. 5-7	33.10	Nov. 11-14	!—2.7	
1895	Apr. 5, 6	24.7	Nov. 16	**—3.8**	
1896	Apr. 23, 24	30.7	Sept. 29, Oct. 2	0.2	
1897	May 13-15	**43.7**	Nov. 4	!—1.4	
1898	Apr. 27-30	37.5	....	....	

MISSISSIPPI RIVER.—BATON ROUGE, LA. (833 MILES BELOW CAIRO.)

[United States Engineer gauge; zero 20.06 feet above the Cairo datum plane.]

Year.	Highest. Day.	Gauge reading.	Lowest. Day.	Gauge reading.	Remarks.
1851	Apr. 1	34.53	Nov. 24	3.20	Major Merrill, Chief of Engineers' Report, 1874, p. 491.
1854	....	....	....	!0.20	
1862	....	36.07	....	....	
1869	....	34.49	....	....	
1871	....	34.52	....	....	
1872	May 7	29.65	Dec. 22	1.15	United States Engineer gauge records.
1873	June 17	29.85	Jan. 1 Oct. 20	2.32 2.35	
1874	Apr. 16	36.15	Nov. 21	2.30	
1875	May 13	29.75	Jan. 1 Dec. 11-13	3.95 4.10	
1876	May 8, 15, 16	33.40	Dec 30, 31	1.70	
1877	June 1, 4	29.65	Jan. 9 Oct. 22, 23	0.90 3.10	
1878	May 19	29.35	Nov. 6	3.30	
1879	Feb. 15-17	26.10	Nov. 21-24	2.00	
1880	Apr. 22-24	33.20	Oct. 13-15, 25, 26	4.00	
1881	Apr. 8	30.05	Sept. 22	2.90	
1882	Mar. 26	35.95	Oct. 18	6.18	
1883	Apr. 9	35.08	Oct. 7	3.10	
1884	Mar. 24	36.20	Oct. 2	4.30	
1885	Jan. 30, 31, Feb. 2	31.90	Oct. 31	4.65	
1886	May 31-June 2	32.10	Nov. 20	2.25	
1887	Apr. 10	33.55	Nov. 26	1.10	

TABLE No. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

MISSISSIPPI RIVER.—BATON ROUGE, LA. (833 MILES BELOW CAIRO.)—Continued.

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1888	Apr. 29-May 3	32.50	Jan. 10 Oct. 21, 22	2.90 3.65	United States Engineer gauge record.
1889	Mar. 13, 14	26.75	Oct. 27, 28	2.50	
1890	Apr. 21, 22	36.60	Aug. 22-24	5.45	
1891	May 3, 5	35.55	Nov. 8, 10, 11	1.20	
1892	June 28	38.45	Oct. 31	2.50	
1893	June 23	38.40	Sept. 14, Dec. 4-5	2.65	
1894	Apr. 5	30.95	Nov. 14	**0.45**	
1895	Apr. 6	23.65	Nov. 16	0.80	
1896	Apr. 23, 24	28.85	Oct. 2	2.56	
1897	May 13-15	**40.65**	Oct. 26	1.4	
1898	Apr. 29, 30	34.60			

MISSISSIPPI RIVER.—PLAQUEMINE, LA. (854 MILES BELOW CAIRO.)

[Mississippi River Commission gauge; zero 21.06 feet above the Cairo datum plane.]

1880	Apr. 23-25	†29.00			Mississippi River Commission gauge records.
1881	Apr. 3-9	†26.00	Sept. 21, 22	†1.70	
1882	Mar. 21-27	†31.30	Oct. 15-18, Nov. 8-11.	†3.80	
1883	Apr. 9	30.80	Oct. 7	1.35	
1884	Mar. 24	31.70	Oct. 1, 2	2.90	
1885	Jan. 30-Feb. 5	27.70			
1889	Mar. 13, 14	23.00	Oct. 30	1.10	
1890	Apr. 22	31.90	Aug. 22, 23	3.65	
1891	Apr. 15-22	31.05	Nov. 13	0.20	
1892	June 13	33.50	Oct. 30	0.50	
1893	June 23	33.75	Dec. 5, 7	0.80	
1894	Apr. 6	26.80	Nov. 14	**—0.94**	
1895	Apr. 6, 7	20.0	Nov. 21	—0.85	
1896	Apr. 22-24	25.1	Oct. 2, 5	1.2	
1897	May 13-17	**36.25**	Nov. 9, 10, 22	0.3	
1898	Apr. 29, 30	30.57			

MISSISSIPPI RIVER.—DONALDSONVILLE, LA. (885 MILES BELOW CAIRO.)

[United States Engineer gauge; zero *a* 19.48 feet above the Cairo datum plane.]

1890			Aug. 21, 22	4.14	United States Engineer gauge records.
1891	Mar. 18, 20	27.90	Nov. 6	1.70	
1892	June 13	30.15	Nov. 9, 10	2.30	
1893	June 23	30.60	Dec. 4	1.90	
1894	Apr. 5, 6	24.35	Nov. 11	**1.00**	
1895	Apr. 6	18.60	Nov. 30	1.25	
1896	Apr. 23, 24	23.05	Oct. 3, 4	2.95	
1897	May 13	**32.75**	Nov. 6, 7, 17, 18, 26	2.05	
1898	Apr. 28, 29	27.95			

a Provisional.

MISSISSIPPI RIVER.—COLLEGE POINT, LA. (904 MILES BELOW CAIRO.)

[Mississippi River Commission gauge; zero 21.24 feet above the Cairo datum plane.]

1880	Apr. 18, 20-23	21.30	Nov. 2	2.65	Mississippi River Commission gauge records.
1881	May 22-24	19.95	Aug. 27, Sept. 19	1.35	
1882	Mar. 26	23.20	Oct. 13, Nov. 7	2.45	
1883	Apr. 9	23.45	Oct. 12, 13	1.40	
1884	Mar. 24	24.10	Dec. 2	1.25	
1885	Jan. 30-Feb. 1	21.10			
1889	Mar. 12-14	17.48	Oct. 28	0.20	
1890	Mar. 16	23.90	Aug. 22	2.22	
1891	do	23.45	Oct. 21	0.00	
1892	June 13	25.62	Oct. 27, Nov. 20	0.25	
1893	June 23	25.90	Dec. 7	0.05	
1894	Apr. 5	20.55	Nov. 14	**—0.91**	
1895	Apr. 6	15.15	Dec. 4	—0.80	
1896	Apr. 22	19.25	Nov. 8	0.52	
1897	May 15	**27.95**	Nov. 10	—0.15	
1898	Apr. 27-30	23.50			

TABLE No. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

MISSISSIPPI RIVER.—CARROLLTON, LA. (967 MILES BELOW CAIRO.)

[United States Engineer gauge; zero 20.91 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1828	Apr. 1	15.2			H. and A. Rep., p. 172.
1844		14.5			H. and A. Rep., p. 172.
1849	Mar. 11-15	15.2	Oct. 6	2.1	H. and A. Rep., p. 516.
1850	Jan. 21, 28, 30, Feb. 2.	13.8	Nov. 18	−0.5	H. and A. Rep., p. 517
1851	Mar. 27-30	15.4	Nov. 24	0.2	H. and A. Rep., p. 521.
1852	May 30	14.1	Feb. 4 Aug. 22, Nov. 2	0.6 2.0	H. and A. Rep., p. 525. H. and A. Rep., p. 525.
1853	May 30, 31, June 2, 3.	?15.0	Oct. 26	?1.2	H. and A. Rep., p. 527.
1854	Apr. 14	?14.7	Dec. 30	?0.0	H. and A. Rep., p. 528.
1858	May 10, 12	15.1	Nov. 5, 7-9	0.4	H. and A. Rep., p. 536.
1859	May 2, 4, 6	15.6	Nov. 13	−0.4	H. and A. Rep., p. 540.
1860	Feb. 6	13.4	Oct. 18	−0.7	H. and A. Rep., p. 541.
1862		15.9			Major Abbot, Chief of Engineers Rep., 1869, p. 337, and 1875, p. 568.
1871		15.4			Major Merrill, Chief of Engineers Rep. 1872, p. 434.
1872	May 6	12.30	Dec. 27	−1.60	United States Engineer gauge records.
1873	June 3, 4	12.93	Nov. 20	0.08	
1874	Apr. 16	15.70	Nov. 24	0.10	
1875	May 3-5, 14-16, 18	11.30	Nov. 13	0.10	
1876	May 11	12.70	Dec. 30	−1.20	
1877	June 4, 8	11.10	Jan. 9 Oct. 7, 22-24	−1.40 0.00	
1878	Mar. 21	11.30	Nov. 22	−0.10	
1879	Feb. 20, 22	10.80	Nov. 24	−0.80	
1880	Apr. 22, 24	13.90	Nov. 2	0.30	High water, Mississippi River Commission discharge party gauge records. Low water, United States Engineer gauge records.
1881	Apr. 12	12.55	Sept. 10	0.30	United States Engineer gauge records.
1882	Mar. 27	14.95	Nov. 8	1.00	
1883	Apr. 7	15.40	Oct. 15	0.50	
1884	Mar. 18	15.60	Dec. 2, 5	0.30	
1885	Jan. 22, 23	13.56	Oct. 24	0.90	
1886	May 31	13.80	Nov. 27	−0.40	
1887	Apr. 6-9	14.50	Nov. 20	−0.70	
1888	Apr. 26	14.70	Jan. 10 Oct. 16, 29	−0.20 0.10	
1889	Mar. 13, 14	11.60	Nov. 9, 11	0.40	
1890	Mar. 13-17	16.10	Aug. 11	1.50	
1891	Mar. 16	16.00	Oct. 21	−0.05	
1892	June 10	17.35	Nov. 21	0.15	
1893	June 22	17.45	Dec. 8	0.30	
1894	Apr. 6	13.50	Nov. 15	−0.05	
1895	Apr. 8	10.15	Jan. 1 Nov. 9, 10, 12, 24, Dec. 23.	0.00 0.05	
1896	Apr. 24	13.70	Oct. 9-11	0.75	
1897	May 13	**19.17**	Nov. 27	0.10	
1898	Apr. 25	15.90			

MISSISSIPPI RIVER.—FORT JACKSON, LA. (1,039 MILES BELOW CAIRO.)

[Mississippi River Commission gauge; zero 19.26 feet above the Cairo datum plane.]

Year.	Highest Day.	Gauge reading.	Lowest Day.	Gauge reading.	Remarks.
1891	Mar. 31	6.9	Nov. 30	0.50	Mississippi River Commission gauge records.
1892	June 13	6.85	Nov. 20	0.50	
1893	June 15	6.70	Dec. 7	0.3	
1894	Apr. 8-9 Oct. 8	5.8 [a]8.0	Nov. 12, 14	0.3	
1895	Apr. 2, 3	4.6	Jan. 9, Dec. 13	0.4	
1896	Apr. 19	5.90	Dec. 4, 5	0.9	
1897	Apr. 22-23, 29, May 14, 16.	**7.2**	Dec. 8	0.85	
1898	Apr. 23, 26	6.7			

[a] Storm on the Gulf.

TABLE No. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

ARKANSAS RIVER.—LITTLE ROCK, ARK. (176 MILES FROM MOUTH.)

[United States Engineer gauge; zero 241.53 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1867	....	31.00	....	....	Major Merrill, Chief of Engineers Rep. 1872, p. 432.
1872	May 20, 21	26.00	Dec. 4, 5, 14, 15	0.80	United States Engineer gauge records.
1873	Apr. 12	22.60	Sept. 23, 26	0.40	
1874	Apr. 25	23.00	Sept. 4–7	0.00	
1875	Aug. 5	21.80	Nov. 27	0.50	
1876	July 7	26.30	Oct. 18	1.00	
1877	June 13	27.50	....	....	
1878	May 28	24.30	....	....	
1879	Feb. 3	16.60	Oct. 23, 24	**—1.00**	
1880	Mar. 15	14.80	May 29, 30	0.80	
1881	Feb. 20	18.40	Jan 15–18 Sept. 17	1.00 1.80	
1882	Feb. 25	25.70	Sept. 23–26	3.30	
1883	Feb. 19	30.60	Oct. 8, 9, 12 13	4.90	
1884	Feb. 15	13.60	Nov. 17–21	4.80	
1885	Apr. 27–29	28.60	Dec. 8, 24–29	4.40	
1886	Feb. 16	17.90	Nov. 8, 9, 16	3.20	
1887	May 6	17.60	Nov. 20	2.00	
1888	May 23	20.30	Oct. 19–Nov. 6	3.40	
1889	Mar. 27	23.30	Oct. 29	3.90	
1890	Apr. 29	26.80	Aug. 17–19	4.50	
1891	Apr. 24	22.70	Nov. 12, 13	3.90	
1892	May 21	**31.20**	Jan. 17 Oct. 13–16	6.00 6.60	
1893	May 3	27.20	Nov. 10–20	4.20	
1894	Mar. 22, 23	24.80	Nov. 29–Dec. 2	3.20	
1895	Dec. 27	25.80	May 29, Nov. 6–11	3.50	
1896	Jan. 1	23.00	Oct. 19, 22, 24, 27, 28	3.75	
1897	Mar. 21	23.20	Oct. 26–31, Nov. 14–16, Dec. 7–11.	2.50	
1898	May 11	29.30	....	....	

ATCHAFALAYA RIVER.—BARBRES LANDING, LA. (0 MILES FROM HEAD.)

[Mississippi River Commission gauge; zero 24.17 feet above the Cairo datum plane.]

1880	....	....	Oct. 27	5.00	United States Engineer gauge records.
1881	Apr. 4–9	40.00	Sept. 18	—1.20	
1882	Mar. 27	49.90	Oct. 16–18	3.60	
1883	Apr. 8–10	46.30	Oct. 17	—0.40	Mississippi River Commission gauge records.
1884	Mar. 30, 31	48.60	Oct. 3, 4	1.7	
1885	Feb. 1–6	41.6	Oct. 30, 31	1.5	
1886	May 29, June 1	41.8	Sept. 13, 14	1.7	
1887	Apr. 9	43.1	Sept. 6–7, 26	0.1	
1888	Apr. 30–May 3	40.7	Oct. 30	0.9	
1889	Feb. 11–13	33.6	Nov. 7	2.4	
1890	Apr. 28	49.7	Aug. 24–27	5.3	
1891	Apr. 25–May 4	45.65	Nov. 7, 8	—1.0	
1892	June 27, 28	49.7	Oct. 25	0.20	
1893	June 26–28	48.70	Nov. 18	0.80	
1894	Apr. 6, 7	39.15	Nov. 12	—1.70	
1895	Apr. 6	29.45	Nov. 13, 21	—1.25	
1896	Apr. 23, 24	35.80	Sept. 30	0.45	
1897	May 13, 14	**50.95**	Oct. 26	**—1.77**	
1898	May 2	42.85	....	....	

ATCHAFALAYA RIVER.—SIMMSPORT, LA. (4 MILES FROM HEAD.)

[United States Engineer gauge; zero 24.17 feet above the Cairo datum plane.]

1884	....	....	Oct. 4	†5.5	Mississippi River Commission gauge records.
1885	Feb. 2–6	†43.9	....	....	
1887	....	....	Oct. 1–3	†—0.65	
1888	Apr. 30, May 1	38.80	Oct. 30	0.48	
1889	Feb. 13	32.19	Nov. 7	2.00	
1890	Apr. 22, 23	45.50	Aug. 26	4.80	
1891	Apr. 26–May 2	43.32	Nov. 8	**—1.60**	
1892	June 24	46.64	Oct. 15	1.57	High water, Mississippi River Commission gauge records. Low water, Mississippi River Commission discharge party.
1897	May 13	**49.33**	....	....	Mississippi River Commission discharge party.
1898	Apr. 29	†40.71	....	....	

TABLE No. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

ATCHAFALAYA RIVER.—WEST MELVILLE, LA. (27 MILES FROM HEAD.)

[United States Weather Bureau gauge; zero 20.17 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1883	....	37.0	....	....	United States Signal Service.
1884	....	....	Oct. 4	†3.85	Mississippi River Commission gauge records.
1885	Feb. 2-8	31.65	Nov. 1	†3.9	High water, Mississippi River Commission gauge records. Low water, United States Signal Service gauge records.
1886	May 28-June 5	31.7	Sept. 14	3.9	United States Signal Service gauge records.
1887	Apr. 8-13	32.1	Sept. 16	1.50	High water, United States Signal Service gauge records. Low water, Mississippi River Commission gauge records.
1888	May 3, 4	31.90	Oct. 21, 30, 31	3.40	Mississippi River Commission gauge records.
1889	Mar. 13-15	28.80	Nov. 6, 7	4.50	
1890	Apr. 27-29	35.4	Aug. 25, 26	7.3	
1891	Apr. 9-May 8	33.7	Nov. 7	1.5	
1892	June 25	35.0	Oct. 24-27	2.80	
1893	June 27-30	35.0	Nov. 17, 18	3.60	
1894	Apr. 6, 7	32.2	Nov. 12, 13	1.0	United States Weather Bureau gauge records.
1895	Apr. 6	27.9	Nov. 21	1.2	
1896	....	....	Oct. 2, 3	3.3	
1897	May 15	36.1	Nov. 19	1.8	

CUMBERLAND RIVER.—NASHVILLE, TENN. (234 MILES FROM CAIRO.)

[United States Engineer gauge.]

1847	....	54.7	....	....	Major Merrill, Chief of Engineers' Report, 1874, p. 489.
1873	....	....	Oct. 14	0.50	United States Engineer gauge records.
1874	Apr. 17	49.60	July 10	0.50	
1875	Mar. 2	41.50	Sept. 18	1.20	
1876	Jan. 29	34.40	Oct. 20, 21	0.30	
1877	Jan. 22	40.50	Oct. 21-23, 25, 26	0.80	
1878	Apr. 26	27.30	Oct. 15, 16	—0.40	
1879	Jan. 19	41.60	Oct. 6, 7, 10, 11, 14-16.	— 0.20	
1880	Mar. 20	46.50	Oct. 15	0.50	
1881	Jan. 25	33.00	Sept. 13, 14	— 0.30	
1882	Jan. 22	55.30	Oct. 26, 27	1.20	
1883	Feb. 14	41.60	Sept. 19-21	0.20	
1884	Mar. 15, 16	48.30	Oct. 25-27	— 0.20	
1885	Jan. 21	37.80	Sept. 13, 29	0.40	
1886	Apr. 10, 11	49.30	Nov. 1	0.50	
1887	Mar. 2	44.30	Sept. 14-17	— 0.20	
1888	Mar. 30	39.20	Aug. 16-18	1.00	
1889	Feb. 21	35.80	Oct. 18	1.70	
1890	Mar. 6	50.70	July 18	1.50	
1891	Mar. 14	49.30	Oct. 16-20. Nov. 2-9	0.00	
1892	Apr. 26	38.80	Nov. 1	— 0.20	
1893	Feb. 22	40.80	Sept. 8-11, 23, 24, Nov. 2, 3.	0.60	
1894	Feb. 9	42.30	Oct. 23, 24, 29-31	— 0.10	
1895	Mar. 25	31.70	Oct. 29, 30	0.1	
1896	Apr. 7	42.90	Sept. 27	0.65	
1897	Mar. 20	49.25	Oct. 25, 26, 31	0.06	
1898	Jan. 23	38.80	....	....	

TABLE NO. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

ILLINOIS RIVER.—PEORIA, ILL. (160 MILES FROM MOUTH.)

[United States Weather Bureau gauge.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1882	June 12-14, 28, 29	14.8	Oct. 1, 7	3.8	United States Weather Bureau gauge records.
1883	Apr. 17	† 13.7	....	....	
1884	Mar. 29-31	17.8	Aug. 21, 25-27, Sept. 15.	3.2	
1885	Apr. 23	15.3	July 7, 8	4.0	
1886	Feb. 19, 20	16.0	July 25-Aug. 4, 6-13, 19, 20, 22-Sept. 9.	3.2	
1887	Feb. 20	18.8	Aug. 13, Sept. 20-22	2.8	
1888	Mar. 31, Apr. 1	14.1	Sept. 27-30	† 3.0	
1889	....	....	Aug. 29, 30	2.9	
1890	June 25, 26	13.3	Oct. 7-12	**2.6**	
1891	Apr. 17-19	15.0	Oct. 16-21	2.7	
1892	May 9	**21.9**	Oct. 15-Nov. 3	4.0	
1893	Mar. 12, 13	19.6	Aug. 23-Sept. 12	3.0	
1894	Mar. 14	12.3	Aug. 11-19	3.1	
1895	Mar. 7	8.1	Jan. 15-28	3.3	
	Dec. 31	15.0	June 23-26	3.1	
1896	Jan. 1	14.7	July 17-19	3.6	
1897	Mar. 24-27	18.3	Sept. 29-Oct. 15, 19	3.7	

ILLINOIS RIVER.—BEARDSTOWN, ILL. (86 MILES FROM MOUTH.)

[United States Weather Bureau gauge; zero *444.26 feet above the Cairo datum plane.]

Year.	Highest. Day.	Highest. Gauge reading.	Lowest. Day.	Lowest. Gauge reading.	Remarks.
1882	....	**21.3**	....	....	United States Signal Service gauge records.
1885	Apr. 23	14.2	Aug. 24	3.2	
1886	Feb. 26	10.0	Aug. 11	0.9	
1887	Feb. 23-25	16.5	Aug. 11, 12	**0.0**	
1888	Apr. 3-5	13.5	Sept. 29, 30	0.7	
1889	June 27, 28	12.0	May 17, 18, 26, 27	† 2.4	
1890	Jan. 20	13.5	Aug. 13-21, 24-Sept. 4, 8-15, 27-Oct. 7.	6.0	
1891	Apr. 24-28	12.8	Oct. 13-23	5.9	United States Weather Bureau gauge records.
1892	May 15, 16	18.4	Oct. 29-31	6.0	
1893	Mar. 14, 15	17.0	Oct. 4, 5	5.4	
1894	Mar. 20-24	9.8	Aug. 8-17	5.7	
1895	Mar. 1	8.6	Oct. 5-14	† 6.0	Gauge discontinued Dec. 1, 1895.

*Approximate.

MISSOURI RIVER.—COLES CREEK, MO. (107 MILES FROM MOUTH.)

[Missouri River Commission gauge; zero 433.97 feet above the Cairo datum plane.]

Year.	Highest. Day.	Highest. Gauge reading.	Lowest. Day.	Lowest. Gauge reading.	Remarks.
1891	July 3	91.5	Dec. 1-3, 17, 18	75.3	Missouri River Commission gauge records.
1892	May 15	**96.76**	Jan. 13	73.5	
			Dec. 26	73.8	
1893	May 1	91.0	Dec. 7-10	71.9	
1894	May 10	88.3	Jan. 15, 16, Feb. 1, 4	72.5	
			Dec. 18-22, 28	73.6	
1895	July 6	87.8	Dec. 10	72.9	
	Dec. 20	90.1			
1896	May 25	93.2	Mar. 17-19	74.4	
			Dec. 8, 9	73.8	
1897	Apr. 30, May 1	90.1	Dec. 24	**70.7**	

MISSOURI RIVER.—HERMANN, MO. (103 MILES FROM MOUTH.)

[United States Weather Bureau gauge; zero 433.99 above the Cairo datum plane.]

Year.	Highest. Day.	Highest. Gauge reading.	Lowest. Day.	Lowest. Gauge reading.	Remarks.
1873	June 10	† 84.10	Dec. 31	† 71.43	Missouri River Commission gauge records.
1874	June 19	84.77	Jan. 21	70.35	
			Dec. 28, 30, 31	72.35	
1875	Aug. 1	90.18	Jan. 5, 6	† 70.68	
			Dec. 8	72.68	
1876	July 6	91.10	Dec. 9, 10	† 71.43	
1877	June 13, 14	90.68	Oct. 18	74.60	

TABLE No. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

MISSOURI RIVER.—HERMANN, MO. (103 MILES FROM MOUTH.)—Continued.

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1878	July 8	86.77	Dec. 21, 22	†**67.35**	Missouri River Commission gauge records.
1879	June 29	87.68	Dec. 22	71.52	
1880	July 15	84.93	Dec. 6	71.52	
1881	May 4	91.93	Jan. 28 Sept. 29	73.52 75.02	
1882	July 3	90.44	Feb. 5 Dec. 17	73.35 68.85	
1883	June 24	†92.68	Jan. 9	69.68	
1884	May 6	86.35	Jan. 4 Dec. 22	†72.02 73.68	
1885	June 16	90.4	Jan. 28 Dec. 30	74.1 †75.0	
1886	May 12	86.4	Jan. 9 Dec. 10	†74.2 72.0	
1887	June 16	85.6	Feb. 4–6 Dec. 24–27	†72.9 72.9	
1888	July 1	88.0	Nov. 3	†72.5	
1889	May 30	87.6	Feb. 12, 13 Dec. 11	71.4 71.7	
1890	Apr. 4	83.1	Jan. 1 Dec. 17–20	71.9 72.5	
1891	July 3	88.6	Dec. 1–3, 17	73.3	
1892	May 15	**92.98**	Dec. 24	†71.7	
1893	May 1	87.4	Nov. 1	†72.2	
1894	June 28	84.9	Jan. 17 Dec. 20–23	†69.7 71.0	

OHIO RIVER.—CINCINNATI, OHIO. (504 MILES FROM MOUTH.)

[City waterworks gauge; zero 447.62 feet above the Cairo datum plane.]

1858	....	....	Sept. 28–Oct. 4	2.42	City waterworks gauge records
1859	Feb. 23	55.83	Sept. 19, 20	3.25	
1860	Apr. 17	49.08	Oct. 3, 4	5.42	
1861	Apr. 20	49.42	July 13	5.08	
1862	Jan. 24	57.83	Oct. 8, 10–14, 31, Nov. 1	2.33	
1863	Mar. 12	42.75	Oct. 6, 7	2.50	
1864	Dec. 23	45.08	Aug. 6	3.08	
1865	Mar. 8	56.17	Oct. 19	5.67	
1866	Sept. 26, 27	41.17	Aug. 17	4.75	
1867	Mar. 15	55.67	Oct. 19, 20	3.00	
1868	Mar. 30	48.25	July 28	5.08	
1869	Apr. 3	48.67	Aug. 27, 28, 31	5.33	
1870	Jan. 19	55.25	Oct. 5	3.83	
1871	May 13	40.50	Oct. 11–14	2.67	
1872	Apr. 13	41.75	Oct. 14–16	3.08	
1873	Dec. 18	44.42	Oct. 12	3.67	
1874	Jan. 13	46.75	Sept. 23	2.33	
1875	Aug. 6	55.33	Sept. 6	3.75	
1876	Jan. 29	51.75	June 21	6.25	
1877	Jan. 20, 21	53.25	Oct. 9	3.25	
1878	Dec. 15	41.33	Oct. 22–24	4.33	
1879	Dec 27	42.75	Oct. 24	2.50	
1880	Feb. 17	53.17	Oct. 28, 29	3.75	
1881	Feb. 16	50.50	Sept. 18	**1.92**	
1882	Feb. 21	58.58	Oct. 31, Nov. 1	6.08	
1883	Feb. 15	66.33	Sept. 20, 21	3.58	
1884	Feb. 14	**71.06**	Sept. 26	2.50	
1885	Jan. 20	46.00	Oct. 11, 12	3.92	
1886	Apr. 9	55.75	Oct. 26, 27, 31–Nov. 2	3.33	
1887	Feb. 5	56.25	Sept. 23	2.67	
1888	Mar. 31	39.75	Aug. 7	5.25	
1889	Feb. 22	38.08	Sept. 12	5.33	
1890	Mar. 26, 27	59.12	Aug. 4	5.50	
1891	Feb. 25	57.87	Oct. 9–16, Nov. 2	4.5	
1892	Apr. 25	43.9	Nov. 5, 6	3.5	
1893	Feb. 21	54.58	Aug. 29, 30	3.58	
1894	Feb. 15	35.58	Sept. 14, 15	3.08	
1895	Jan. 14	48.4	Oct. 27, 28	2.30	
1896	Apr. 4	47.67	Sept. 25	5.42	
1897	Feb. 26	61.1	Oct. 18, 26, 27	3.1	
1898	Mar. 24	61.4	....	....	

TABLE No. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

OHIO RIVER.—LOUISVILLE (UPPER), KY. (364 MILES FROM MOUTH.)

[United States Engineer gauge; zero [a]419.76 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1832	....	40.8	....	....	Major Merrill, Chief of Engineers' Report, 1873, p. 518.
1851	Mar. 2	20.8	Oct. 5	1.5	Louisville and Paducah Canal records, corrected by deducting 35 feet. Major Merrill, Chief of Engineers' Report, 1872, p. 429.
1856	....	....	....	1.1	Major Merrill, Chief of Engineers' Report, 1873, p. 518.
1858	June 17	19.1	Sept. 28	1.5	Louisville and Paducah Canal records, corrected by deducting 35 feet. Major Merrill, Chief of Engineers' Report, 1872, p. 429.
1859	Feb. 24	83.8	Sept. 20	2.0	
1866	Jan. 1	18.6	Aug. 18	2.8	
1867	Mar. 15	37.6	Oct. 22	1.8	
1868	Mar. 31	22.3	July 30	8.0	
1869	Apr. 4	24.3	Aug. 25	2.8	
1872	Apr. 14	20.95	Oct. 17–18	2.00	United States Engineer gauge records.
1873	Dec. 19	18.30	Sept. 27	2.30	
1874	Feb. 26	22.35	Sept. 22–26	1.75	
1875	Aug. 7	80.30	Sept. 20	2.70	
1876	Jan. 30	82.50	Dec. 18–19	3.70	
1877	Jan. 21–22	29.90	Oct. 11–12	2.20	
1878	Dec. 17	15.50	Oct. 27	2.90	
1879	Dec. 28–29	19.60	Oct. 18–27, Nov. 13	2.20	
1880	Feb. 19	80.00	Oct. 2–5, 29	2.80	
1881	Feb. 17	22.50	Sept. 10–14, 18–22	1.70	
1882	Feb. 22	37.40	Oct. 30–Nov. 4	4.70	
1883	Feb. 16	43.80	Sept. 24–25	3.20	
1884	...do	46.60	Sept. 23–25, 27	2.00	
1885	Jan. 21	21.70	Oct. 11–14	2.90	
1886	Apr. 10	82.70	Oct. 28–Nov. 2	2.40	
1887	Feb. 6	82.60	Nov. 22	2.00	
1888	Apr. 1-2	16.10	Aug. 12	3.60	
1889	Feb. 22–23	13.80	Sept. 15	3.80	
1890	Mar. 28	35.40	Aug. 7–9	8.60	
1891	Feb. 27	82.40	Oct. 28–29	2.50	
1892	Apr. 23	21.80	Nov. 8	2.00	
1893	Feb. 21	28.89	Aug. 24–Sept. 4	2.00	
1894	Feb. 15	35.58	Sept. 14–15	3.08	
1895	Jan. 15	20.70	Nov. 14–15	1.70	
1896	Apr. 5	22.40	Sept. 11–13	8.30	
1897	Feb. 28	35.30	Sept. 21–27, 28, 29	2.40	
1898	Mar. 30	36.20	....	....	

[a] Preliminary value.

OHIO RIVER.—LOUISVILLE (LOWER), KY. (364 MILES FROM MOUTH.)

[United States Engineer gauge; zero [a]392.85 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
1832	....	67.5	....	....	Major Merrill, Chief of Engineers' Report, 1872, p. 430.
1856	....	....	....	1.0	
1858	June 17	42.8	Oct. 3	1.5	Louisville and Paducah Canal records. Corrected by deducting 8 feet. Major Merrill, Chief of Engineers' Report, 1872, p. 430.
1859	Feb. 24	57.5	Sept. 20	2.5	
1866	Sept. 27	41.8	Aug. 18	4.7	
1867	Mar. 15	62.2	Oct. 22	3.0	
1868	Jan. 11	48.8	Oct. 29	5.1	
1869	Apr. 4	49.0	Nov. 17	4.1	
1872	Apr. 14	45.37	Oct. 17, 18	1.60	
1873	Dec. 19	42.80	Oct. 1–5, 8. 11–17	3.01	United States Engineer gauge records.
1874	Feb. 26	47.60	Nov. 15, 16	2.80	
1875	Aug. 8	55.00	Sept. 20–22	4.10	
1876	Jan. 30	58.00	Dec. 18	5.30	
1877	Jan. 20–22	55.20	Oct. 11	8.10	
1878	Dec. 17	42.50	Oct. 27	3.70	
1879	Dec. 28, 29	44.60	Oct. 18-26, Nov. 11-12	2.80	
1880	Feb. 19	55.50	Oct. 4, 5	8.60	
1881	Feb. 17	47.60	Sept. 21–22	2.60	
1882	Feb. 22	63.00	Nov. 1	5.80	
1883	Feb. 16	70.10	Sept. 23–24	3.40	
1884	.....do	72.00	Sept. 24	2.90	
1885	Jan. 21	47.00	Oct. 14	3.70	
1886	Apr. 10	58.40	Oct. 28	3.20	
1887	Feb. 6	58.40	Oct. 21	2.70	
1888	Apr. 1	40.60	Aug. 12, 13	5.00	

TABLE NO. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

OHIO RIVER.—LOUISVILLE (LOWER), KY. (364 MILES FROM MOUTH.)—Continued.

Year.	Highest.		Lowest.		Remarks.
	Day.	Guage reading.	Day.	Guage reading.	
		Feet.		*Feet.*	
1889	Feb. 23	36.60	Sept. 15	4.80	United States Engineer guage records.
1890	Mar. 28	61.20	Aug. 6–9	7.60	
1891	Feb. 26, 27	58.00	Oct. 16–18	4.10	
1892	Apr. 23	47.40	Nov. 7	2.70	
1893	Feb. 22	54.40	Sept. 1–3	3.10	
1894	Feb. 14	35.20	Sept. 7	2.60	
1895	Jan. 15	46.10	Oct. 19–27, Nov. 6–8	2.00	
1896	Apr. 5	47.80	Sept. 26–28	4.80	
1897	Feb. 28	61.00	Oct. 1	2.40	
1898	Mar. 30	62.00	....	....	

a Preliminary value.

OHIO RIVER.—PADUCAH, KY. (45 MILES FROM MOUTH.)

[United States Weather Bureau gauge; zero 308.40 feet above the Cairo datum plane.]

Year.	Highest day.	Guage reading.	Lowest day.	Guage reading.	Remarks.
1856	....	....	....	0.00	United States Signal Service.
1867	Mar. 21	51.97	....	....	High-water mark, Mississippi River Commission, discharge party. Mr. Bateman gives 53.0.
1874	....	....	Nov. 8–10	0.92	United States Signal Service gauge records.
1875	Mar. 21	44.33	Oct. 24	3.25	
1876	Feb. 5	44.92	Dec. 29–30	0.25	
1877	Jan. 27	38.83	Sept. 15–16	0.25	
1878	Apr. 29	29.00	Oct. 30–31	0.92	
1879	Jan. 25	38.83	Oct. 16	0.80	
1880	Mar. 22, 23	44.00	Oct. 12–13	1.90	
1881	Feb. 23, 24	40.60	Sept. 17	0.00	
1882	Feb. 26	49.95	Nov. 5	2.94	Mississippi River Commission discharge party.
1883	Feb. 25	50.70	Sept. 16–18	1.00	United States Signal Service gauge records.
1884	Feb. 23	**54.25**	Nov. 11–15	1.60	Mississippi River Commission gauge records.
1885	Jan. 25	38.00	Oct. 19	2.50	High water, Mississippi River Commission gauge records. Low water, United States Signal Service gauge records.
1886	Apr. 17	50.40	Oct. 31–Nov. 5, 9–10	1.50	United States Signal Service gauge records.
1887	Mar. 8	46.80	Oct. 26	0.80	
1888	Apr. 4–6	40.60	Aug. 16	2.90	
1889	Feb. 26	31.40	Oct. 21–23	2.30	
1890	Mar. 11	48.50	July 23–24	4.10	
1891	Mar. 4	45.8	Nov. 4–6	1.0	United States Weather Bureau gauge records.
1892	Apr. 29	42.9	Oct. 30–Nov. 2	0.7	
1893	Feb. 27	44.3	Sept. 4–5	1.0	
1894	Feb. 15, 16	36.3	Nov. 1–2, 4, 7	—0.2	
1895	Jan. 20, 21	32.8	Oct. 30–Nov. 4	**—0.7**	
1896	Apr. 11	37.3	Sept. 24–27	1.6	
1897	Mar. 24, 25	50.9	Oct. 8–11	—0.8	

OUACHITA RIVER.—CAMDEN, ARK. (325 MILES FROM MOUTH RED RIVER.)

[United States Engineer gauge; zero 91.38 feet above the Cairo datum plane.]

Year.	Highest day.	Guage reading.	Lowest day.	Guage reading.	Remarks.
1882	May 12	**46.0**	....	....	United States Signal Service.
1885	....	....	Dec. 8	†3.4	United States Signal Service gauge records.
1886	Nov. 27	26.8	Sept. 12–13	2.8	
1887	Dec. 13	35.7	Aug. 29–30	**1.8**	
1888	Jan. 18	34.2	Oct. 16–21	2.3	
1889	Jan. 21	37.7	Oct. 25–30	2.3	
1890	Apr. 7	38.5	Aug. 6	3.5	
1891	Feb. 5	35.6	Nov. 4–9	2.90	United States Engineer gauge records.
1892	June 6	37.10	Oct. 12–14	3.50	
1893	Jan. 5–6	34.80	Nov. 4	2.70	
1894	Mar. 23	43.25	Oct. 31, Nov. 1	2.80	
1895	Mar. 18	30.70	Oct. 26–31	3.00	
1896	Feb. 6–7	34.00	Sept. 25–26	2.15	
1897	Mar. 23	38.75	Oct. 18–30	2.40	
1898	Jan. 25	33.80	....	....	

TABLE NO. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

OUACHITA RIVER.—MONROE, LA. (175 MILES FROM MOUTH RED RIVER.)

[United States Weather Bureau gauge; zero 51.22 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1874		48.57			High-water marks.
1882		**48.6**			
1884			Sept. 21–27	0.92	United States Signal Service gauge records.
1885	Jan. 19	48.3	Oct. 18–28	0.9	
1886	May 24	30.1	Sept. 11–13	1.0	
1887	Mar. 31–Apr. 4	33.6	Oct. 17–23	0.1	
1888	Apr. 6–18	34.2	Oct. 13–23	0.8	
1889	Feb. 9–14	34.0	Oct. 29–Nov. 6	0.9	
1890	May 14–15	43.2	Sept. 12–13	2.2	United States Weather Bureau gauge records.
1891	Mar. 16–18	38.5	Nov. 4–9	0.90	
1892	June 27–29	41.1	Oct. 19	1.7	
1893	Jan. 9–11, 13–15	40.2	Nov. 3–5	1.1	
1894	Apr. 10–11	45.0	Oct. 27–28, Nov. 1–2	1.0	
1895	Apr. 1–13	26.1	Oct. 16–29, 31–Nov. 8	0.8	
1896	Apr. 21–22	33.0	Sept. 23–24	0.2	
1897	Apr. 9–12	37.9	Sept. 24–Oct. 31	**0.00**	

RED RIVER.—FULTON, ARK. (508 MILES FROM MOUTH.)

[United States Engineer gauge; zero 244.78 feet above the Cairo datum plane.]

1876	July 17	**35.75**			United States Signal Service gauge records.
1885			Dec. 16	3.4	
1886	Apr. 21	20.9	Aug. 4–7, Sept. 10–11, 25.	3.3	
1887	Dec. 12	27.5	Sept. 7	0.6	
1888	May 7	31.8	Nov. 1–3	3.4	
1889	Jan. 20	30.8	Oct. 28–31	4.0	
1890	May 3	34.0	Aug. 16–19	4.35	United States Engineer gauge records.
1891	Apr. 27–28	30.3	Dec. 2–3	3.8	
1892	May 23–24	34.85	Oct. 14	5.2	
1893	Mar. 13	26.80	Nov. 20	3.35	
1894	Mar. 24	33.00	Nov. 27–Dec. 7	2.85	
1895	July 18	31.55	Nov. 8–9	2.40	
1896	Jan. 1	21.80	Sept. 19–25, Oct. 20–22.	**0.10**	
1897	Mar. 23	28.60	Nov. 23-25, Dec. 1–10	1.00	
1898	May 11	27.90			

RED RIVER.—GARLAND, ARK. (450 MILES FROM MOUTH.)

[United States Engineer gauge; zero 223.44 feet above the Cairo datum plane.]

1885		28.34			Major Willard's gauge inspection report, 1890.
1890	Apr. 30	28.17	Aug. 17–18	2.86	United States Engineer gauge records.
1891	Apr. 28	27.64	Nov. 20	2.12	
1892	May 24–25	28.40	Oct. 14	2.66	
1893	Mar. 13–14	25.70	Nov. 19–20	1.69	
1894	Mar. 24	**28.50**	Nov. 30–Dec. 2	1.10	
1895	July 19	28.38	Jan. 5–6 Nov. 8	1.28 1.90	
1896	Jan. 1	23.81	Sept. 22–25	**—0.20**	
1897	Mar. 24	27.57	Nov. 24, Dec. 7–9	0.20	
1898	May 11	27.70			

TABLE NO. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

RED RIVER.—SHREVEPORT, LA. (320 MILES FROM MOUTH.)

[United States Engineer gauge; zero * 161.27 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1873	June 8-9	25.5	Sept. 28	1.4	United States Signal Service gauge records.
1874	Apr. 29-May 1	27.9	Sept. 6-7	—1.2	
1875	Apr. 22	25.8	Nov. 22-23	5.2	
1876	July 28	31.9	Nov. 13	5.2	
1877	May 11-12	29.8	Oct. 15	5.0	
1878	Jan. 31	28.4	Nov. 21	3.5	
1879	May 16-17	24.9	Nov. 1-4	0.0	
1880	Apr. 4	23.2	Oct. 28-29	4.5	
1881	Mar. 7	27.3	Sept. 1-2	—1.4	
1882	Feb. 21	31.4	July 30	8.0	
1883	Mar. 11-12	25.3	Oct. 16-17	0.7	
1884	May 14	32.7	Sept. 24	—0.2	
1885	May 11-12	30.5	Oct. 24	0.7	
1886	Apr. 29	18.3	Sept. 12	—1.0	
1887	Dec. 24-25	21.[illegible]	Sept. 8-11	—0.6	
1888	May 19	30.[illegible]	Nov. 4-6	0.6	
1889	Feb. 3	31.9	Sept. 4, 10	4.3	
1890	May 3	34.7	Aug. 22-24	—0.2	United States Signal Service and United States Engineer gauge records.
1891	Feb. 12-13	25.20	Nov. 14-16, 20	—1.50	United States Engineer gauge records.
1892	May 28	**35.70**	Oct. 13-15	—2.00	
1893	Jan. 1-2	29.10	Oct. 1-2, Nov. 20	—2.60	
1894	Apr. 2	34.40	Dec. 2-4	**—5.50**	
1895	July 29-30	30.30	Jan. 6-7 Oct. 19	—4.90 —3.70	
1896	Feb. 25-26	17.50	Oct. 16-20	—3.40	
1897	Apr. 11-13	24.10	Nov. 27-Dec. 14	—2.00	
1898	May 21	15.00	....	....	

* Preliminary value.

RED RIVER.—ALEXANDRIA, LA. (110 MILES FROM MOUTH.)

[United States Engineer gauge; zero 64.46 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
1849	....	35.36	....	....	Major Merrill, Chief of Engineers, Report, 1873, p. 521.
1866	....	36.46	....	....	United States Engineer gauge records.
1872	Apr. 29-May 1	33.30	Dec. 7-12	—2.60	
1873	June 19-20	30.20	Sept. 24	0.00	
1874	May 8-10	34.90	Sept. 26, 28	—2.00	
1875	Apr. 27	23.90	Nov. 22-23	—3.20	
1876	Apr. 17	32.80	Nov. 16-24	—1.90	
1877	May 18-19	25.45	Oct. 14-15	—2.60	
1878	Mar. 13	†27.1	Nov. 24	—2.60	
1879	May 26	19.20	Nov. 1-5	—3.10	
1880	Apr. 11-13	21.80	Oct. 27-30	—1.60	
1881	Mar. 20	27.85	Sept. 29	**—3.70**	
1882	Mar. 17-19	34.85	Oct. 8	1.25	
1883	Mar. 27	25.45	Oct. 19, 21-22	—2.30	
1884	May 30-31, June 1 5	35.25	Nov. 3-5	—1.90	
1885	Jan. 25	34.30	Oct. 24	—2.05	
1886	June 17	27.90	Sept. 11-13	—2.20	
1887	Dec. 28-29	19.30	Sept. 14-16	—3.00	
1888	Mar. 27-28	29.60	Nov. 7	—2.25	
1889	Feb. 13	31.50	Sept. 13-14	0.25	
1890	May 19	36.85	Aug. 21	—0.10	
1891	Feb. 16-17	29.95	Nov. 16, 19-20	—1.85	
1892	June 12-13	**38.25**	Oct. 20-23	—0.65	
1893	Jan. 7	32.25	Nov. 20	—1.40	
1894	Apr. 12	35.15	Dec. 2-3	—2.25	
1895	Aug. 5	28.20	Nov. 19	—1.90	
1896	Feb. 6	26.50	Sept. 24-25, Oct. 20	—3.30	
1897	Apr. 14-15	26.25	Nov. 25-28	—3.10	
1898	Jan. 23	17.40	....	....	

TABLE No. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

ST. FRANCIS RIVER.—BRIDGE ST. LOUIS, IRON MOUNTAIN AND SOUTHERN RAILWAY. (194 MILES FROM MOUTH.)

[Mississippi River Commission gauge.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1893	May 21–22	41.10	Sept. 23–25	1.00	Mississippi River Commission gauge records.
1894	Mar. 21	25.00	Nov. 20–22	0.52	
1895	Mar. 22	10.80	Nov. 1–2	†0.50	
1896	Apr. 16–18	17.5	Oct. 20–22	0.5	
1897	Apr. 4–6	**41.6**	Nov. 15–25	**0.3**	
1898	Apr. 17–19	34.1			

ST. FRANCIS RIVER.—WITTSBURG, ARK. (180 MILES FROM MOUTH.)

[Mississippi River Commission gauge.]

Year.	Highest. Day.	Highest. Gauge reading.	Lowest. Day.	Lowest. Gauge reading.	Remarks.
1884			Nov. 19	—1.66	Mississippi River Commission gauge records.
1885	Jan. 26	20.37	Oct. 10	—2.55	
1886	Apr. 28	**42.02**	Sept. 25.	—2.53	
1887	Mar. 19–20	38.92	Oct. 29–31	—2.90	
1888	Apr. 24	26.70	Oct. 19	—2.70	
1889	Jan. 30	12.51	Nov. 6–7	—2.48	
1890	Mar. 26–27	40.15	Sept. 27	—3.24	
1891	Mar. 21	36.98	Nov. 3–7	—3.52	
1892	May 9	39.4	Oct. 27–31, Nov. 10–14	**—3.60**	
1893	May 20–23	40.10	Sept. 21, 22, 27–Oct. 3	—2.30	

TENNESSEE RIVER.—CHATTANOOGA, TENN. (475 MILES FROM CAIRO.)

[United States Weather Bureau gauge; zero 651.90 feet (approximately) above the Cairo datum plane.]

Year.	Highest. Day.	Highest. Gauge reading.	Lowest. Day.	Lowest. Gauge reading.	Remarks.
1867	Mar. 11	†58.05			United States Signal Service gauge records.
1874			Nov. 7–8	0.67	
1875	Mar. 1	**54.00**	Oct. 27–31	2.17	
1876	Jan. 1	31.08	Oct. 18–20	1.00	
1877	Apr. 11	28.67	Oct. 5	1.17	
1878	Feb. 25	19.17	Sept. 14–15	0.92	
1879	Jan. 15	38.00	Oct. 6–7, 9–10	0.17	
1880	Mar. 18	38.33	Oct. 16, 24, 27–28, 30	1.00	
1881	Feb. 13	22.42	Sept. 11–14	**0.00**	
1882	Jan. 19	40.17	Oct. 18, Nov. 11–12.	1.67	
1883	Jan. 23	38.17	Sept. 19	**0.00**	
1884	Mar. 10	42.83	Oct. 19–21	0.17	
1885	Nov. 9	30.40	Sept. 20	0.70	
1886	Apr. 3	52.20	Oct. 23–26	1.20	
1887	Feb. 28–Mar. 1	27.30	Oct. 15–17	1.20	
1888	Mar. 31	27.00	July 29	1.80	
1889	Feb. 18	29.60	Oct. 22–24	2.10	
1890	Mar. 2	42.50	July 17	2.00	
1891	Mar. 11	38.9	Nov. 4–10	1.2	United States Weather Bureau gauge records.
1892	Jan. 17	37.9	Oct. 26–Nov. 1	1.1	
1893	Feb. 20	33.4	Aug. 28–29, 31	1.6	
1894	Feb. 6	25.5	Oct. 27–29, Nov. 18.	0.7	
1895	Jan. 12	32.1	Oct. 23–30	0.7	
1896	Apr. 5	40.50	Oct. 29–30	1.1	
1897	Mar. 14–15	37.9	Oct. 8–10	0.4	

TENNESSEE RIVER.—FLORENCE, ALA. (275 MILES FROM CAIRO.)

[United States Engineer gauge; zero 418.03 feet above the Cairo datum plane.]

Year.	Highest. Day.	Highest. Gauge reading.	Lowest. Day.	Lowest. Gauge reading.	Remarks.
1867		31.1			Major Merrill, Chief of Engineers Report, 1872, p. 430.
1871				0.0	
1872	Dec. 25	16.35	Oct. 24, 28	**—0.76**	United States Engineer gauge records.
1873	Feb. 22	22.90	Oct. 21–23	—0.45	
1874	Apr. 17	26.00	Nov. 10	0.02	
1875	Mar. 8	29.38	Nov. 3	0.43	
1876	Jan. 4	19.78	Oct. 21	—0.56	
1877	Apr. 10	19.35	Aug. 28	—0.03	
1878	Apr. 26	13.55	Sept. 18	**—0.76**	
1879	Jan. 20	21.45	Oct. 6	—0.50	
1880	Mar. 18	24.50	Oct. 22–23, 27	0.05	
1881	Mar. 21	17.40	Sept. 14	0.03	
1882	Jan. 22	29.60	Nov. 15–16	1.15	
1883	Jan. 28	23.30	Sept. 13–26	0.40	
1884	Mar. 14–15	25.20	Oct. 24–28	0.25	
1885	Jan. 20	17.80	Sept. 20–22	0.55	
1886	Apr. 8	28.10	Oct. 15–Nov. 1, 10–13	0.50	

TABLE No. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

TENNESSEE RIVER.—FLORENCE, ALA. (275 MILES FROM CAIRO.)—Continued.

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1887	Feb. 27–Mar. 1	17.50	Sept. 21–26, 28–29, Oct. 12–23.	0.50	United States Engineer gauge records.
1888	Mar. 29	20.75	July 31–Aug. 4	0.70	
1889	Feb. 20–21	19.70	May 28–29	1.15	
1890	Mar. 2–3	23.30	July 19–20	1.70	
1891	Mar. 15	22.20	Oct. 19–Nov. 9	1.00	
1892	Apr. 8	24.00	Oct. 28–Nov. 2	0.80	
1893	Feb. 17	21.40	Aug. 31, Sept. 1	1.10	
1894	Feb. 9	17.70	Oct. 27, 30–Nov. 2	—0.10	
1895	Jan. 17	17.50	Oct. 13–14, 27–30	0.0	
1896	Apr. 9	20.00	Oct. 28–Nov. 8	0.10	
1897	Mar. 19	**32.20**	Oct. 11	—0.50	
1898	Jan. 27–29	18.80			

WABASH RIVER.—MOUNT CARMEL, ILL. (190 MILES FROM CAIRO.)

[United States Weather Bureau gauge; zero 397.81 feet above the Cairo datum plane.]

1875	Aug. 7	**28.3**			United States Signal Service gauge records.
1884			Sept. 16, 17, 20, 21	†1.1	
1885	Jan. 8	24.7	Sept. 11, 12	2.0	
1886	May 22	19.8	Sept. 20–21, Nov. 9–12.	1.4	
1887	Mar. 14	22.0	Sept. 25–29, Oct. 30–Nov. 24.	0.6	
1888	Apr. 4, 5	20.6	Sept. 22, Oct. 5–22	1.0	
1889	June 18	21.4	Oct. 16–23	0.9	
1890	Jan. 13–15	25.1	Aug. 16–21	1.4	United States Weather Bureau gauge records.
1891	Mar. 2	22.0	Nov. 7–9	0.4	
1892	Apr. 13	21.5	Oct. 13–22	0.6	
1893	May 8–9	24.5	Sept. 4–29	0.8	
1894	Feb. 15	14.4	Oct. 29–Nov. 25	0.7	
1895	Jan. 10	7.2	Nov. 7–23	**—0.2**	
1896	July 29, 31	14.3	Sept. 28	2.0	
1897	Mar. 13	26.4	Oct. 21–Nov. 1	0.50	

WHITE RIVER.—JACKSONPORT, ARK. (360 MILES FROM MOUTH.)

[United States Engineer gauge.]

1867		32.83			Major Morrill, Chief of Engineers' Report, 1872, p. 431.
1871				0.00	
1872	May 24	22.00	Dec. 24	**—1.10**	United States Engineer gauge records.
1873	Apr. 13	30.00	Sept. 2	—0.70	
1874	Apr. 23	31.05	Nov. 3–4	—0.50	
1875	May 6	26.80	Oct. 29	—0.03	
1876	Jan. 31	31.65	Dec. 28	0.50	
1877	June 13	26.40	Oct. 7	0 20	
1878			Nov. 14	0.32	
1879	Feb. 8	12.32	Nov. 3–7	—0.60	
1880	Mar. 12	27.10	Sept. 13, 14, 17, 18, Oct. 9.	0.20	
1881	Feb. 22	27.10	Aug. 28, Sept. 21	1.00	
1882	May 11	31.20	Aug. 29–30, Sept. 5–6.	1.20	
1883	Feb. 19	32.00	Sept. 23	1.20	
1884	Feb. 15	32.80	Nov. 11–17	0.60	
1885	Jan. 2	30.90	Sept. 2–7, Oct. 24, Nov. 3–4, Dec. 8.	0.80	
1886	May 12	24.00	Sept. 9–11, Nov. 1–2.	0.20	
1887	May 7	25.30	Nov. 19–23	—0.40	
1888	May 23	26.90	Aug. 10–11, Oct. 11–22.	0.30	
1889	Mar. 27–28	24.00	Oct. 23–30	0.80	
1890	Mar. 14	**33.35**	Aug. 9–10	2.40	
1891	Apr. 26	23.75	Oct. 10–Nov. 4	0.50	
1892	May 20	30.40	Oct. 13–14	0.80	
1893	May 3–5	31.15	Sept. 23–24, Nov. 14–22.	1.00	
1894	May 11	28.90	Nov. 30–Dec. 1	0.70	
1895	Dec. 24	30.00	Nov. 5–7	0.35	
1896	Jan. 1	19.40	Oct. 23	0.22	
1897	Jan. 7	28.85	Oct. 6–10, 25–30	—0.15	
1898	Mar. 30	32.50			

TABLE No. 9.—*Highest and lowest annual stages of the Mississippi River and principal tributaries, referred to present or most recent gauges*—Continued.

WHITE RIVER.—CLARENDON, ARK. (134 MILES FROM MOUTH.)

[Mississippi River Commission gauge; zero 158.9 feet (approximate) above the Cairo datum plane.]

Year.	Highest.		Lowest.		Remarks.
	Day.	Gauge reading.	Day.	Gauge reading.	
		Feet.		*Feet.*	
1884	....	....	Nov. 19-20	6.20	
1885	Jan. 8	33.58	Oct. 27-31	5.98	Mississippi River Commission gauge records.
1886	May 4	29.20	Nov. 12-13	5.35	
1887	Mar. 22	27.90	Nov. 22	**4.07**	
1888	Apr. 8-9	25.70	Aug. 15	5.88	
1889	Apr. 11	29.10	Oct. 31-Nov. 1	6.60	
1890	Mar. 20	**36.63**	Aug. 12	8.74	
1891	Mar. 19	29.10	Nov. 1-6	5.75	
1892	May 27-28	82.65	Oct. 19-20	6.45	
1893	May 11	83.95	Nov. 16-20	6.50	
1894	Feb. 20	30.80	Nov. 5-6	6.20	
1895	July 24-26	24.20	Nov. 3-8	5.50	
1896	Jan. 5-6	28.20	Oct. 17-18, 26-27	5.32	
1897	Apr. 14	82.40	Oct. 27-30	4.75	
1898	Apr. 5	85.47	....	....	

YAZOO RIVER.—YAZOO CITY, MISS. (65 MILES FROM MOUTH.)

[United States Weather Bureau gauge; zero 93.34 feet above the Cairo datum plane.]

1875	....	....	....	**—4.30**	United States Signal Service.
1882	....	**36.50**	....	....	
1884	....	....	Nov. 22	—1.21	Mississippi River Commission gauge records.
1885	Feb. 5-7	22.82	Sept. 8	—2.35	
1886	May 11-12	22.40	Nov. 8-10	—0.95	
1887	Mar. 22-28	23.80	Nov. 23	—2.30	
1888	Apr. 26-28	23.90	Aug. 15	—0.20	
1889	Mar. 9-11	18.50	Oct. 30-Nov. 1.	—1.92	
1890	Apr. 26-27	28.82	Aug. 27	0.00	
1891	Mar. 8	28.98	Nov. 8	—1.70	
1892	Apr. 29-30	27.40	Oct. 31	—1.00	
1893	May 23-24	25.6	Nov. 3-9	—1.0	United States Weather Bureau gauge records.
1894	Apr. 10-11	24.5	Nov. 7-16	—1.9	
1895	Apr. 1-5	18.9	Oct. 25-30	—2.5	
1896	Apr. 14-20	21.4	Oct. 15-17, 20-22	—2.8	
1897	Apr. 27-May 2	81.5	Oct. 2-4, 31	—2.7	

Observations for the determination of the discharge of the Mississippi River and its principal tributaries below Cairo, Ill.

Continuous observations for ascertaining the discharge of the Mississippi River were carried on under the commission in 1879 and 1880 at Columbus, Ky., Fulton, Tenn. and Carrollton, La. These observations covered a period of three months at Columbus, one year at Fulton, and ten months at Carrollton.

From the fall of 1881 to the fall of 1882 a more extended series of observations was carried out by parties stationed at Columbus, Ky., Helena, Ark., Hays Landing, Miss., and Red River Landing, La. Observations were also made at Paducah, Ky.

In 1883 and 1884 another extended series of observations was made at Point Pleasant, Mo., Helena, Ark., Arkansas City, Ark., Warrenton, Miss., Red River Landing, La., and Carrollton, La.

Six parties were also in the field at the following points above Cairo: Prescott, Wis., Winona, Minn., Clayton, Iowa, Hannibal, Mo., Grafton, Ill., and St. Louis, Mo. These parties were engaged continuously on discharge work for about a year.

In addition to the above, a large number of observations have been made at various points during the extreme high and low stages.

At present the secretary of the Mississippi River Commission is charged with securing discharge measurements at or near high and low water at the following point: Columbus, Ky., Helena, Ark., Arkansas City, Ark., Warrenton, Miss., Red River Landing, La., and Carrollton, La., all on the main river; also at the following points on the tributaries below Cairo: St. Francis River, near its mouth; White River, 15 miles above the mouth; Arkansas River, about 1 mile above cut-off to White River; Yazoo River, at Yazoo and Mississippi Valley Railway bridge; Red River, at Joffrions Landing, about 32 miles above mouth of river; Black River, near Davids Landing, about 2 miles above its mouth, and the Atchafalaya River at Simmsport, La. The high-water discharge measurements are confined to floods that reach an overflow stage.

The results of the discharge observations taken during the past year are given in the following tables, which have been prepared under the direction of Mr. Kivas Tully:

TABLE NO. 10.

Results of discharge observations, Mississippi River, Columbus, Ky. (21 miles below Cairo).

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Mississippi River Commission, Belmont.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1897.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Nov. 3	2.4	2.42	0.0	63,469	178,748	24.7	57.4	35.8	2,573
4	2.4	2.35	0.0	64,419	179,877	25.0	57.7	36.0	2,573
5	2.4	2.35	0.0	64,774	180,232	25.2	57.9	36.0	2,573
5		2.34		65,010		25.3			2,573
5		2.31		65,201	180,762	25.3	58.0	37.0	2,573
6	2.2	2.24	—0.1	64,660	180,401	25.1	57.9	36.8	2,573
6		2.23		64,453	180,220	25.1	57.9	35.7	2,573
6		2.22		64,387		25.0			2,573
8	2.2	2.18	0.0	63,875	179,770	24.8	57.7	37.2	2,571
8		2.19		64,266	180,136	25.0	57.8	35.7	2,571
8		2.20		63,874	179,718	24.8	57.7	35.8	2,571
1898.									
Feb. 1	40.5	40.47	0.0	176,000	182,783	56.6	58.7	77.6	3,108
3	40.1	40.07	—0.3	175,376	183,402	56.4	58.9	73.8	3,106
3		39.98		175,096		56.4			3,106
4	39.6	39.37	—0.4	174,086	184,286	56.1	59.2	74.2	3,103
5	38.7	38.55	—0.8	173,254	185,997	55.9	59.7	73.7	3,100
5		38.35		172,634		55.7			3,100
Mar. 29	41.6	41.68	+0.4	184,883	187,904	59.4	60.3	78.4	3,114
31	42.5	42.54	+0.5	185,977	186,320	59.7	59.8	78.8	3,115
31		42.66		186,351		59.8			3,115
Apr. 1	43.0	43.05	+0.5	188,190	186,944	60.4	60.0	79.7	3,115
1		43.16		188,532		60.5			3,115
2	43.4	43.50	+0.4	189,490	186,842	60.8	60.0	79.8	3,115
2		43.57		189,708		60.9			3,115
4	43.8	43.80	+0.1	192,958	189,376	61.9	60.8	82.5	3,115

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
1897.	*Sq. feet.*	*Feet.*	*Cubic feet.*				
Nov. 3	+ 349	1.223	77,629	F.	12	60	V—Very light.
4	+1,129	1.401	90,237	M.	13	53	V—Brisk.
5	+ 355	1.425	92,283	M.	13	53	VIII—Brisk.
5		1.329	86,429	M.	13		VIII—Light.
5	+ 530	1.343	87,566	F.	11	53	VIII—Very light.
6	— 861	1.336	86,391	M.	13	53	IV—Nearly calm.
6	— 181	1.337	86,160	M.	13	53	Do.
6		1.343	86,504	F.	11		Do.
8	— 450	1.344	85,845	M.	13	53	V—Very light.
8	+ 366	1.375	88,342	M.	13	53	Do.
8	— 418	1.112	71,059	F.	11	53	Do.
1898.							
Feb. 1	+3,065	6.978	1,228,151	M.	9	26	X—Very light.
3	+ 619	6.735	1,181,080	M.	14	54	V—Very light.
3		6.705	1,173,962	F.	14		V—Brisk.
4	+ 884	6.761	1,176,945	M.	14	54	V—Brisk to strong.
5	+1,711	6.399	1,108,609	M.	14	54	X-XI—Brisk to light.
5		6.342	1,094,771	F.	14		X—Very light.
Mar. 29	+1,907	7.724	1,428,088	M.	14	34	XII—Very light.
31	—1,584	7.911	1,471,259	M.	14	55	I—Very light.
31		8.138	1,516,609	F.	13		
Apr. 1	+ 624	7.724	1,453,542	M.	14	55	Do.
1		7.679	1,447,712	F.	14		XI—Nearly calm.
2	— 102	7.974	1,510,958	M.	14	55	X—Very light.
2		7.865	1,492,029	F.	12		IX—Nearly calm.
4	+2,434	7.560	1,458,756	M.	14	55	III—Very light.

NOTES.—The discharge section was at same place as in former years, about one-half mile below the Belmont elevator. Datum line is taken at 42.65 feet on the Belmont gauge whose zero is 286.85 feet above the Cairo datum. F = Double floats. M = Haskell meter.

TABLE No. 10—Continued.

Results of discharge observations, Mississippi River, Helena, Ark. (306 miles below Cairo).

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	United States Engineer.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1897.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Nov. 17	0.4	0.50	+0.2	47,081	....	25.9	....	47.4	1,817
18	0.6	0.68	+0.2	48,039	....	26.4	....	47.5	1,818
18	....	0.70	....	49,212	....	27.1	....	47.0	1,819
18	....	0.76	....	48,074	....	26.4	....	47.2	1,820
18	....	0.79	....	49,369	....	27.1	....	47.3	1,820
19	1.0	1.12	+0.4	49,280	....	26.9	....	47.5	1,833
19	....	1.16	....	50,144	....	27.3	....	47.5	1,834
19	....	1.22	....	49,640	....	27.0	....	47.5	1,836
19	....	1.27	....	49,860	....	27.2	....	47.6	1,836
20	1.5	1.60	+0.5	49,555	....	26.9	....	47.8	1,845
1898.									
Apr. 9	45.6	45.70	+0.5	198,097	214,067	40.2	43.4	93.6	4,925
11	46.9	47.00	+0.7	206,097	216,259	41.8	43.8	95.1	4,933
12	47.5	47.53	+0.6	208,838	....	42.3	....	....	4,933
12	....	47.66	+0.6	209,480	216,386	42.5	43.9	95.4	4,933
13	48.0	48.14	+0.6	214,000	218,538	43.4	44.3	95.8	4,933
14	48.4	48.60	+0.4	212,153	214,422	43.0	43.5	95.0	4,933
15	48.8	48.85	+0.4	213,281	....	43.2	....	....	4,933
15	....	48.90	....	213,528	214,317	43.3	43.5	97.2	4,933
16	49.0	49.05	+0.2	215,399	215,448	43.7	43.7	96.7	4,933

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
1897.	*Sq. feet.*	*Feet.*	*Cubic feet.*				
Nov. 17	....	2.099	98,832	M.	10	37	I—Brisk to light.
18	....	2.094	100,607	M.	11	37	I—Nearly calm.
18	....	2.132	104,903	M.	10	37	Calm.
18	....	2.070	99,529	F.	10	37	Do.
18	....	2.061	101,758	F.	10	37	Do.
19	....	2.174	107,126	M.	10	37	V—Nearly calm.
19	....	2.198	110,214	M.	10	37	Do.
19	....	2.175	107,973	M.	10	37	VI—Very light.
19	....	2.173	108,335	F.	10	37	VI—Nearly calm.
20	....	2.299	113,915	M.	10	37	V—Very light.
1898.							
Apr. 9	....	6.432	1,274,121	M.	19	73	IX to V—Very light.
11	+2,192	6.423	1,323,836	M.	19	73	I—Very light.
12	....	6.821	1,424,428	F.	19	....	II—Very light.
12	+ 127	6.550	1,372,225	M.	19	74	Nearly calm.
13	+2,152	6.486	1,388,050	M.	19	74	IX—Strong.
14	−4,116	6.622	1,404,957	M.	19	74	X—Strong.
15	....	6.680	1,424,643	F.	19	....	XII—Nearly calm.
15	− 105	6.580	1,405,037	M.	19	74	I—Very light.
16	+1,131	6.471	1,393,853	M.	19	74	V—Very light.

NOTES.—The discharge section was at same place as in 1896, about one-half mile below Helena. Datum line was taken at 49.06 feet on the United States Engineer gauge whose zero is 161.98 feet above the Cairo datum. Owing to emergence of sand bar at low stages the datum areas have not been computed for low-water series.

TABLE No. 10—Continued.

Results of discharge observations, Mississippi River, Arkansas City, Ark. (438 miles below Cairo).

Date.	Gauges.			Cross section of discharge.					
	Mississippi River Commission.	Local.	Rise or fall in preceding 24 hours.	Area.		Depth.			
				Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1897.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Nov. 26	0.5	0.40	+0.1	56,469	228,529	18.5	65.8	42.1	3,045
27	0.6	0.51	+0.1	57,027	228,752	18.7	65.9	41.9	3,046
27	....	0.53	....	57,112	228,776	18.8	65.9	41.5	3,046
29	0.8	0.84	+0.1	56,038	226,757	18.4	65.3	41.0	3,050
29	....	0.86	....	56,614	227,272	18.6	65.5	40.8	3,050
29	....	0.89	....	56,577	227,143	18.5	65.4	41.2	3,050
29	....	0.93	....	56,907	227,351	18.7	65.5	41.0	3,050
30	0.9	1.17	+0.1	56,870	226,581	18.6	65.3	41.1	3,054
30	....	1.20	....	57,163	226,783	18.7	65.3	40.9	3,054
30	....	1.25	....	57,332	226,799	18.8	65.3	41.3	3,056
1898.									
Apr. 20	51.1	51.14	0.0	243,112	New sec.	68.2	....	96.6	3,566
20	....	51.14	....	243,112	....	....	....	....	3,566

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
1897.	*Sq. feet.*	*Feet.*	*Cubic feet.*				
Nov. 26	—3,131	2.228	125,836	M.	17	66	IX—Brisk.
27	+ 223	2.342	133,545	M.	16	61	XI—Brisk.
27	+ 24	2.323	132.653	M.	12	61	Do.
29	—2,019	2.343	131,293	M.	12	61	XI—Strong.
29	+ 515	2.373	134,345	M.	12	61	Do.
29	— 129	2.407	136,187	M.	12	61	XI—Brisk.
29	+ 208	2.354	133,933	M.	12	61	Do.
30	— 770	2.383	135,810	F.	16	61	XII—Nearly calm.
30	+ 202	2.314	132,260	F.	16	61	Calm.
30	+ 16	2.385	136,714	M.	16	61	Do.
1898.							
Apr. 20	....	6.156	1,496,792	M.	18	77	XI—Nearly calm.
20	....	6.225	1,513,532	F.	18	....	Do.

NOTES.—The discharge section was at same place as in former years, about one-half mile below Arkansas City; the right bank end being about 75 feet below the new sawmill, in January, 1898, the left bank end of the section was moved downstream 5° from its former position to make it more nearly normal to direction of flow. Datum line was taken at 51.89 feet on the Arkansas City gauge, whose zero is 116.44 feet above the Cairo datum. F = Double floats. M = Haskell meter.

TABLE No. 10—Continued.

Results of discharge observations, Mississippi River, Warrenton, Miss. (608 miles below Cairo).

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			Width.
	Vicksburg.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	
1897.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Dec. 6	2.4	52.90	+0.9	84.900	260,012	25.7	69.2	42.9	3,310
7	2.9	53.10	+0.5	87,375	261,824	26.4	69.7	42.5	3,313
7		53.12		86,430	260,813	26.1	69.4	42.4	3,313
7		53.15		86,749	261,033	26.2	69.5	41.8	3,313
8	3.0	53.32	+0.1	87,381	261,102	26.4	69.5	42.7	3,322
8		53.34		87,106	260,760	26.3	69.4	42.6	3,322
8		53.38		87,508	261.029	26.4	69.5	42.5	3,322
8		53.42		87,062	260,450	26.3	69.3	42.6	3,322
9	3.2	53.53	+0.2	87,490	260,513	26.4	69.4	42.8	3,324
9		53.56		87,107	260,030	26.3	69.2	42.6	3,324
1898.									
Apr. 24	49.40	100.25	+0.1	254,577	New sec.			89.1	4,217
25	49.40	100.27	0.0	256,935					4,217
25		100.27		256,935				87.6	4,217

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
1897.	*Sq. ft.*	*Feet.*	*Cubic feet.*				
Dec. 6	+1,227	1.931	163,961	M.			VII—Very light.
7	+ 1,812	1.961	171,369	M.			Calm.
7	− 1,011	1.948	168,346	M.			VII—Nearly calm.
7	+ 220	1.984	172,154	F.			VII—Very light.
8	+ 69	1.983	173,291	F.			VI—Nearly calm.
8	− 342	1.867	162,603	F.			VI—Light; river rough.
8	+ 269	1.923	168,289	M.			VII—Light; river rough.
8	− 579	1.943	169,174	M.			VII—Very light.
9	− 63	2.046	179,002	M.			IV—Very light.
9	− 483	2.048	178,425	M.			V—Nearly calm.
1898.							
Apr. 24		5.654	1,439,814	M.			I—Very light.
25		5,359	1,376,845	F.			XII—Nearly calm.
25		5.665	1,455,578	M.			Calm.

NOTES.—The discharge section is near present landing below Warrenton, Miss., at same place as in former years, about 607.8 miles below Cairo on the inch-to-mile map. January, 1898, right bank end was swung downstream 15° to make the section more nearly normal to the direction of the flow. The datum line was taken at 102.27 feet on high-water gauge No. 74, used as local gauge, whose zero is 18.13 feet above the Cairo datum. The Vicksburg gauge zero is 66.04 feet above the Cairo datum. F = Double floats. M = Haskell meter.

TABLE No. 10—Continued.

Results of discharge observations, Mississippi River, Red River Landing, La. (765 miles below Cairo).

Date.	Gauges.			Cross section of discharge.					
	U. S. Engineer.	Local.	Rise or fall in preceding 24 hours.	Area.		Depth.			Width.
				Water.	Below datum.	Mean.	Mean datum.	Maximum.	
1897.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Dec. 13	5.30 5.30	5.32	0.0	60,872	235,187	16.7	57.7	41.1	3,636
13		5.34		60,872					3,636
14	5.00 5.00	5.06	—0.3	59,415	234,675	16.4	57.6	40.6	3,631
14		5.04		60,060	235,393	16.5	57.7	39.9	3,630
14		5.00		59,285	234,762	16.3	57.6	40.4	3,629
14		4.97		59,465	235,051	16.4	57.7	40.7	3,629
15	4.70 4.70	4.72	—0.3	58,970	235,463	16.3	57.8	40.4	3,625
15		4.73		59,530	235,987	16.4	57.9	40.0	3,625
15		4.74		59,383	235,804	16.4	57.9	40.6	3,627
15		4.74		59,383					3,627
1898.									
Apr. 28	44.30 44.30	44.30	0.0	192,583	216,591	47.2	53.1	81.4	4,076
28		44.30		192,583					4,076

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
1897.	*Sq. feet.*	*Feet.*	*Cubic feet.*				
Dec. 13	— 2,477	2.961	180,238	M.	15	50	X—Brisk.
13		2.987	181,820	M.	15		X—Very light.
14	— 512	3.177	188,751	F.	15	50	X—Brisk.
14	+ 718	3.189	191,547	F.	15	50	X—Very light.
14	— 631	3.082	182,688	M.	15	50	Do.
14	+ 289	2.085	183,428	M.	15	50	X—Nearly calm.
15	+ 412	3.094	182,450	M.	15	50	V—Light.
15	+ 524	3.136	186,667	M.	15	50	Do.
15	— 183	3.071	182,344	M.	15	50	Do.
15		3.122	185,380	F.	14		VI—Very light.
1898.							
Apr. 28	—19,213	5.629	1,084,183	M.	16	64	VII—Very light.
28		5.887	1,133,813	F.	16		Do.

NOTES.—The discharge section was just below Red River Landing at the same place as in former years. Datum line was taken at 50.19 feet on the United States Engineer gauge at Red River Landing, whose zero is 23.85 feet above the Cairo datum. F = Double floats. M = Haskell meter.

TABLE No. 10—Continued.

Results of discharge observations, Atchafalaya River, Simmsport, La. (4 miles below head).

Date.	Gauges.			Cross section of discharge.					
	M. R. C., Barbre Landing.	Local.	Rise or fall in preceding 24 hours.	Area.		Depth.			Width.
				Water.	Below datum.	Mean.	Mean datum.	Maximum.	
1897.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Dec. 18	4.5	28.47	0.0	26,697	68,302	36.4	62.1	58.7	734
18		28.47		26,713	68,318	36.4	62.2	57.7	734
18		28.48		26,663	68,259	36.3	62.1	57.6	734
18		28.48		26,716	68,312	36.4	62.2	57.6	734
18		28.49		26,636	68,223	36.3	62.1	57.6	734
20	5.7	29.63	+0.9	27,396	68,146	36.8	62.0	58.4	744
20		29.64		27,580	68,321	37.0	62.2	58.7	744
20		29.66		27,448	68,171	36.9	62.0	58.6	744
20		29.75		27,407	68,067	36.8	61.9	58.6	745
20		29.78		27,518	68,151	36.9	62.0	58.7	745
1898.									
Apr. 29	42.6	64.88	+0.1	58,474	67,710	56.0	61.6	91.7	1,044

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
1897.	*Sq. feet.*	*Feet.*	*Cubic feet.*				
Dec. 18	+2,051	0.702	18,753	M.	8	31	XI—Very light.
18	+ 16	0.759	20,288	M.	6	31	Do.
18	— 59	0.720	19,186	M.	6	31	Do.
18	+ 53	0.710	18,976	F.	6	31	XI—Nearly calm.
18	— 89	0.592	15,758	F.	6	31	Do.
20	— 77	0.627	17,182	F.	8	31	Calm.
20	+ 175	0.844	23,272	F.	8	31	V—Nearly calm.
20	— 150	0.924	25,349	M.	8	31	V—Very light.
20	— 104	1.007	27,603	M.	8	31	IV—Very light.
20	+ 84	0.783	21,552	M.	8	31	Do.
1898.							
Apr. 29	— 441	4.392	256,840	M.	11	36	V—Very light.

Zero of Barbre Landing gauge is 24.17 feet above Cairo datum. Zero of local gauge is at Cairo datum.

NOTES.—Section is same as used in 1896 and 1897, being between sill dams 1 and 3 and just above mouth of Alligator Bayou.

Alligator Bayou is dry in low water. The high-water discharge as measured Apr. 29, 1898, was 518 cubic feet.

TABLE No. 10—Continued.

Results of discharge observations, Mississippi River, Carrollton, La. (957 miles below Cairo).

Date.	Gauges.			Cross section of discharge.					
	United States engineer.	Local.	Rise or fall in preceding 24 hours.	Area.		Depth.			Width.
				Water.	Below datum.	Mean.	Mean datum.	Maximum.	
1897.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Dec. 27	0.95 1.10	1.48 1.06	+0.4	145,293	185,573	66.8	78.9	93.5	2,174
27	....	0.98 0.90	....	145,190	186,186	67.0	79.2	93.4	2,168
28	1.05 1.00	1.30 1.14	0.0	147,097	187,486	67.7	79.8	92.8	2,174
28	....	1.12 0.87	....	146,529	187,395	67.5	79.7	92.7	2,170
29	1.00 0.95	1.02 0.96	0.0	146,184	187,072	67.4	79.6	93.2	2,169
29	....	0.95 0.97	....	145,258	186,211	67.0	79.2	91.9	2,169
30	0.95 0.90	1.06 1.13	0.0	145,765	186,414	67.1	79.3	92.6	2,171
30	....	1.18 1.25	....	146,120	186,509	67.3	79.4	92.8	2,171
31	0.95 1.00	1.09 1.14	0.0	145,972	186,578	67.2	79.4	92.8	2,171
31	....	1.15 1.25	....	146,422	186,854	67.4	79.6	92.9	2,172
1898.									
May 2	15.65 15.65	15.87	0.0	172,682	179,497	73.5	76.4	106.9	2,350
3	15.60 15.60	15.85	....	174,457	....	74.2	....	....	2,350
3	....	15.86	....	174,481	181,320	74.2	77.2	105.4	2,350
4	15.65 15.50	15.80	0.0	175,602	....	74.7	....	....	2,350
4	....	15.80	....	175,602	182,582	74.7	77.7	105.8	2,350

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
1897.	*Sq. feet.*	*Feet.*	*Cubic feet.*				
Dec. 27	....	2.062	299,627	M.	13	43	XI—Very light.
27	+ 613	2.043	296,620	M.	13	43	Calm to XI, very light.
28	+ 1,300	1.878	276,318	F.	13	43	XI—Light.
28	— 91	1.932	283,128	M.	13	43	Do.
29	— 323	1.738	254,073	F.	13	43	Calm.
29	— 861	1.852	269,051	M.	13	43	VI—Nearly calm.
30	+ 203	1.619	235,953	F.	14	43	VII—Light.
30	+ 95	1.803	263,467	M.	12	43	Do.
31	+ 69	1.974	288,132	M.	13	43	XII—Brisk.
31	+ 276	1.976	289,381	M.	13	43	Do.
1898.							
May 2	— 7,357	6.278	1,084,091	M.	13	51	VII—Very light.
3	....	6.024	1,050,873	F.	11	....	V—Very light.
3	+ 1,823	6.284	1,096,411	M.	13	51	Variable, very light.
4	....	5.974	1,049,022	F.	12	....	VI—Very light.
4	+ 1,262	6.188	1,086,666	M.	13	51	VII—Light.

The discharge section is at same place as in former years, about 1½ blocks above Carrollton avenue.

Datum line was taken at 18.77 feet on the United States Engineer gauge, which was at the section. Its zero is 20.91 feet above the Cairo datum. F = double floats; M = meter.

GENERAL NOTES.—OBSERVATIONS ON THE MISSISSIPPI RIVER.—The meter observations were observed with the Haskell current meter at $\frac{6}{10}$ depth, generally run for 200 seconds at each station. The float observations were made with double floats, the lower one being at mid depth. The surface float was an air-tight sheet-iron buoy, circular on plan and elliptical in cross-section, axes 5 inches and 10 inches; this carried a small flag. The lower float was a sheet-iron cylinder, with open ends, about 6 inches diameter and 12 inches high, suspended from the upper float by a fine string. Float ranges were mainly 400 feet apart. Soundings were taken with a five-sixteenths-inch braided cotton line; 12-pound lead used in low-water and 20-pound lead in high-water observations.

Direction of flow was derived from float observations, and meter observations were corrected for any variation from the normal.

The values of meter constants used are as follows: For low-water series: Meter wheel No. 6, rating of Jan. 10, 1898, $a = 1.14013$; $b = 0.4197$. For high-water series: Meter wheel No. 2, $a = 1.8778$; $b = 0.3884$ (this wheel was broken on Mar. 31, 1898), rating of Jan. 10, 11, 1898. Meter wheel No. 1-1, rating of May 12, 1898, $a = 2.12627$; $b = -0.0598$ for velocities over 2 feet, and $a = 1.95$; $b = 0.158$ for lower velocities.

Meter was operated from skiff during low-water period and from the steamer *Search* during high water.

TABLE No. 10—Continued.

Results of discharge observations, St. Francis River (400 meters above the mouth).

Date.	Gauges.			Cross section of discharge.						
	Helena.	Local.	Rise or fall in preceding 24 hours.	Area.		Depth.				Width.
				Water.	Below datum.	Mean.	Mean datum.	Maximum.		
1897.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*		*Feet.*
Nov. 16	*a* 0.2	150.78	+0.3	420	424	4.2	4.3	5.9		99
16	0.2	150.78	....	420	424	4.2	4.3	5.9		99
16	0.2	150.79	....	420	423	4.2	4.3	5.9		99
16	0.2	150.80	....	423	425	4.3	4.3	5.9		99
16	0.2	150.82	....	410	410	4.1	4.1	6.0		99
16	0.2	150.82	....	422	422	4.3	4.3	6.0		99
16	0.2	150.82	....	416	416	4.2	4.2	5.9		99
16	0.2	150.81	....	425	426	4.3	4.3	5.9		99
16	0.2	150.81	....	422	423	4.3	4.3	6.0		99
16	0.2	150.81	....	428	429	4.3	4.3	5.9		99

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
1897.	*Sq. feet.*	*Feet.*	*Cubic feet.*				
Nov. 16	....	2.390	1,005	Meter	4	9	IV—Very light.
16	− 0.1	2.272	955	do	4	9	II—Very light.
16	− 1.0	2.271	955	do	4	9	Do.
16	+ 1.4	2.299	972	do	4	9	Do.
16	−14.7	2.410	988	Double floats.	4	9	Do.
16	+12.0	2.345	990	Meter	4	9	IV—Very light.
16	− 6.5	2.374	986	do	4	9	Do.
16	+10.1	2.350	998	do	4	9	Do.
16	− 2.6	2.433	1,027	do	4	9	Do.
16	+ 5.6	2.483	1,062	Double floats.	4	9	Do.

a Helena United States Engineer gauge, whose zero is 161.98 feet above Cairo datum. Zero of local gauge is 13.13 feet above Cairo datum.

NOTES.—The discharge section is 400 meters above the mouth of the St. Francis River. Datum line is taken at 150.82 feet on the local gauge as observed Nov. 16. Soundings were taken with a pole.

TABLE No. 10—Continued.

Results of discharge observations, White River, 8 miles above the cut-off (16 miles above the mouth).

Date.	Gauges.			Cross section of discharge.					
	Mouth of White River.	Local.	Rise or fall in preceding 24 hours.	Area.		Depth.			
				Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1897.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Nov. 23	[a]5.6	—5.89	+0.2	3,541	7,318	7.4	14.3	9.8	480
23	5.6	—5.88	....	3,508	7,280	7.3	14.3	9,8	480
23	5.6	—5.89	....	3,513	7,290	7.3	14.3	9.7	480
23	5.6	—5.89	....	3,493	7,270	7.3	14.3	9.5	480
23	5.6	—5.88	....	3,528	7,300	7.3	14.3	9.7	480
23	5.6	—5.88	....	3,528	7,300	7.3	14.3	9.5	480
23	5.6	—5.89	....	3,530	7,307	7.4	14.3	9.8	480
23	5.6	—5.89	....	3,523	7,299	7.3	14.3	9.6	480
23	5.6	—5.89	....	3,507	7,284	7.3	14.3	9.7	480
23	5.6	—5.88	....	3,529	7,301	7.4	14.3	9.7	480

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
1897.	*Sq. ft.*	*Feet.*	*Cubic feet.*				
Nov. 23	....	1.344	4,759	Meter ..	6	21	XII—Brisk.
23	—38	1.335	4,684	....do ...	6	19	Do.
23	+10	1.347	4,733	....do ...	6	19	Do.
23	—20	1.359	4,749	....do ...	6	19	Do.
23	+30	1.333	4,701	....do ...	6	19	Do.
23	....	1.282	4,523	....do ...	6	19	Do.
23	+ 7	1.322	4,668	....do ...	6	19	Do.
23	— 8	1.238	4,362	Double floats.	7	19	XII—Very light.
23	—15	1.272	4,459	....do ...	8	20	XII—Nearly calm.
23	+17	1.275	4,498	....do ...	11	20	Calm.

[a] Mouth of White River, United States Engineer gauge, whose zero is 128.73 feet above Cairo datum. Local gauge is identical with the one used in November, 1896, and is not connected with Cairo datum.

NOTES.—The discharge section is about 16 miles above the mouth of White River and 8 miles above cut-off (mouth of Arkansas River), and is identical with section used in November, 1896. Datum line is taken at 1.74 feet on the local gauge, as observed November 28, 1896. Soundings were taken with a pole.

TABLE No. 10—Continued.

Results of discharge observations, Arkansas River, Little Rock, Ark.

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	United States Engineer.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1898.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet*
May 10	a 28.80	b 27.05	+0.7	57,165	....	36.9	....	....	1,550
11	29.30	27.25	+0.5	57,342	....	37.0	....	48.0	1,550
12	28.80	27.05	—0.5	58.984	....	37.9	....	46.0	1,557
13	28.00	26.8	—0.8	56,663	....	36.3	....	45.0	1,562

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
1898.	*Sq. ft.*	*Feet.*	*Cubic feet.*				
May 10	....	10.243	585,524	F.	8	....	Calm.
11	....	11.802	676,756	F.	8	18	X—Very light.
12	....	11.153	657,859	F.	9	25	IX—Light.
13	....	9.442	535,032	F.	7	32	XI—Very light.

a At Little Rock, zero is 241.53 feet above the Cairo datum. *b* U. S. Weather Bureau.

NOTES.—Discharge section was about 3,000 feet below Little Rock and Fort Smith Railroad (lower) bridge. Soundings were made under difficulties, owing to very swift current and inexperienced leadsman. 10-pound lead was used. Distance between float ranges, 275 feet. Time was observed with a common watch. All angular locations of soundings and floats were with sextant from skiff. Area of May 10 mainly computed from soundings of May 11.

Arkansas River, near mouth.

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	United States Engineer.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1897.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Nov. 24	a 2.6	c 2.0	0.0	941	....	5.6	....	7.8	170
24	....	2.0	....	930	....	5.5	....	7.9	170
24	....	2.0	....	943	....	5.6	....	7.9	170
24	....	2.0	....	943	....	5.6	....	7.9	170
24	....	2.0	....	937	....	5.5	....	7.9	170
24	....	2.0	....	944	....	5.6	....	7.9	170
24	....	2.0	....	942	....	5.6	....	8.0	170
24	....	2.0	....	944	....	5.6	....	7.9	170
24	....	2.0	....	937	....	5.5	....	7.9	170
24	....	2.0	....	936	....	5.5	....	8.3	170

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
1897.	*Sq. ft.*	*Feet.*	*Cubic feet.*				
Nov. 24	....	1.954	1,839	F.	7	7	VI—Very light.
24	....	1.823	1,696	F.	7	7	Do.
24	....	1.927	1,817	F.	7	7	Do.
24	....	1.949	1,838	M.	5	7	Do.
24	....	1.963	1,838	M.	5	7	VI—Nearly calm.
24	....	1.956	1,847	M.	5	7	Do.
24	....	1.955	1,842	M.	5	7	Do.
24	....	1.937	1,829	M.	5	7	Calm.
24	....	1.927	1,805	M.	5	7	VI—Very light.
24	....	1.958	1,832	M.	7	15	Do.

c Temporary gauge.

NOTES.—Discharge section is in the cut-off, about 1 mile above mouth of Arkansas River, and about 9 miles above mouth of White River. There is no water in the old mouth of the Arkansas River. Float ranges were 80 feet apart. Soundings were taken with a pole.

TABLE No. 10—Continued.

Results of discharge observations, Yazoo River, near Yazoo and Mississippi Valley Railroad bridge (16 miles above the mouth).

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Yazoo City.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1897.	*Feet.*	*Feet,*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Dec. 4	[a]0.6?	73.15	+0.4?	9,576	....	21.8	....	32.0	438
4	0.6	73.17	....	9,573	....	21.8	....	32.1	438
4	0.6	73.21	....	9,640	....	22.0	....	32.2	438
4	0.6	73.21	....	9,594	....	21.9	....	32.0	438
4	0.6	73.21	....	9,631	....	21.9	....	32.8	439
4	0.6	73.21	....	9,581	....	21.8	....	32.2	439
4	0.6	73.21	....	9,593	....	21.9	....	32.4	439
4	0.6	73.21	....	9,621	....	21.9	....	32.1	439

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
1897.	*Sq. feet.*	*Feet.*	*Cubic feet.*				
Dec. 4	....	0.778	7,454	Double floats.	15	20	VII—Very light.
4	....	0.741	7,097	....do ...	8	18	Do.
4	....	0.924	8,906	Meter ..	6	23	Do.
4	....	0.907	8,707	....do ...	6	23	VII—Nearly calm.
4	....	0.862	8,303	....do ...	6	23	Do.
4	....	0.874	8,376	....do ...	6	23	VII—Very light.
4	....	0.880	8,446	....do ...	6	23	Do.
4	....	0.858	8,254	....do ...	6	23	VII—Nearly calm.

[a] Yazoo City, Miss., gauge, whose zero is 93.34 feet above Cairo datum. Local gauge is the United States Engineer gauge on draw pier of Yazoo and Mississippi Valley Railroad bridge; is graduated in meters, and has its zero at Cairo datum.

NOTE.—The discharge section is 200 meters below the Yazoo and Mississippi Valley Railroad bridge, about 16 miles above mouth of Yazoo River.

TABLE NO. 10—Continued.

Results of discharge observations, Black River, near Davids Landing, Louisiana (2 miles above the mouth).

Date.	Gauges.			Cross section of discharge.						
	Barbre Landing.	Local.	Rise or fall in preceding 24 hours.	Area.		Depth.				
				Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.	
1897.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
Dec. 16	*a* 4.7	30.09	—0.3	5,391	10,532	12.2	19.8	17.2	442	
16	4.7	30.09	....	5,377	10,517	12.2	19.8	17.2	442	
16	4.7	30.08	....	5,348	10,494	12.1	19.7	16.9	442	
16	4.7	30.08	....	5,346	10,491	12.1	19.7	16.7	442	
16	4.7	30.07	....	5,344	10,494	12.1	19.7	16.6	442	
16	4.7	30.07	....	5,344	10,494	12.1	19.7	16.7	442	
16	4.7	30.06	....	5,361	10,516	12.1	19.8	16.7	442	
16	4.7	30.06	....	5,333	10,488	12.1	19.7	16.6	442	
17	4.5	29.85	—0.2	5,266	10,507	12.0	19.7	16.5	440	
17	4.5	29.84	....	5,264	10,510	12.0	19.8	16.5	440	

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
1897.	*Sq. feet.*	*Feet.*	*Cubic feet.*				
Dec. 16	....	1.861	10,034	Meter...	6	25	VI—Light.
16	—15	1.846	9,923	....do ...	6	23	VI—Very light.
16	—23	1.786	9,552	....do ...	6	23	V—Very light.
16	— 3	1.796	9,599	....do ...	6	23	Do.
16	+ 3	1.805	9,645	....do ...	6	23	Do.
16	....	1.694	9,054	Double floats.	6	23	Do.
16	+22	1.684	9,029	....do ...	6	23	V—Nearly calm.
16	—28	1.788	9,534	....do ...	6	23	Do.
Dec. 17	+19	1.775	9,344	Meter...	6	23	Do.
17	+ 3	1.773	9,333	....do ...	6	23	VI—Very light.

a Barbre Landing, Mississippi River Commission gauge, whose zero is 24.17 feet above Cairo datum. Zero of local gauge is at Cairo datum.

NOTES.—The discharge section is 2 miles above the mouth of Black River, about 32 miles from the mouth of Red River, and about 150 meters below Davids Landing, Louisiana. Is identical with section used in December, 1896. Datum line is taken at 40.64 feet, Cairo datum, as observed on local gauge December 18, 1896.

TABLE NO. 10—Continued.

Results of discharge observations, Red River, near Joffrion Landing, Louisiana (32 miles above the mouth).

Date.	Gauges.			Cross section of discharge.						
	Barbre Landing.	Local.	Rise or fall in preceding 24 hours.	Area.		Depth.				Width.
				Water	Below datum.	Mean.	Mean datum.	Maximum.		
1897.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*		*Feet.*
Dec. 17	a 4.5	30.62	—0.2	2,672	6,033	9.6	15.3	12.8		280
17	4.5	30.62	....	2,642	6,003	9.5	15.2	12.8		280
17	4.5	30.61	....	2,663	6,027	9.5	15.3	12.7		280
17	4.5	30.61	....	2,643	6,007	9.5	15.2	12.6		280
17	4.5	30.58	....	2,638	6,013	9.4	15,3	12.6		280
17	4.5	30.58	....	2,645	6,016	9.5	15.3	12.7		279
17	4.5	30.57	....	2,640	6,015	9.5	15.3	12.5		279
17	4.5	30.57	....	2,638	6,013	9.4	15.3	12.6		279
17	4.5	30.57	....	2,638	6,013	9.4	15.3	12.7		279
17	4.5	30.57	....	2,640	6,016	9.5	15.3	12.6		279

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
1897.	*Sq. feet.*	*Feet.*	*Cubic feet.*				
Dec. 17	....	1.653	4,417	Meter ..	6	11	VII—Very light.
17	—30	1.645	4,348	....do ...	5	11	Calm.
17	+24	1.610	4,288	....do ...	4	11	Calm; raining.
17	—20	1.651	4,364	....do .	4	11	Do.
17	+ 6	1.553	4,096	Double floats.	6	11	XII—Very light; raining.
17	+ 3	1.731	4,578	....do ...	6	11	Do.
17	— 1	1.710	4,513	....do ...	6	11	Do.
17	— 2	1.592	4,199	....do ...	6	11	XII—Nearly calm.
17	....	1.531	4,118	Meter ..	6	11	Calm; raining.
17	+ 3	1.566	4,134	....do ...	4	11	Do.

a Barbre Landing, Mississippi River Commission gauge, whose zero is 24.17 feet above the Cairo datum. The zero of the local gauge is at Cairo datum.

NOTES.—The discharge section is 32 miles above the mouth of Red River, and 2 miles above the mouth of the Black River, and about 200 meters above Joffrion Landing, Louisiana. Identical with section used in December, 1896. Datum line is taken at 40.60 feet Cairo datum, as observed on local gauge December 19, 1896.

GENERAL NOTES—OBSERVATIONS ON THE TRIBUTARIES.—The following methods were employed except when otherwise noted: The floats were similar to those described for the main river, except that the lower float consisted of two sheets of sheet iron, 10 by 12 inches, fastened together at centers, forming in plan a cross, thus, +, 10 inches high.

Float ranges were generally 100 feet apart. The lower float was run at mid depth.

The Haskell current meter was used. It was suspended from the stern of a skiff, held at six-tenths depth, and generally run for 200 seconds. The skiff was held in position by a wire stretched across the river. The wheel used was No. 6, with "a" = 1.1268 and "b" = 0.4306, derived from rating of January 10, 1898.

Soundings were taken with a $\frac{3}{16}$-inch line and 10-pound lead, except where otherwise noted.

COMPUTATION AND REDUCTION OF FIELD NOTES.

Progress has been made on reducing and platting the field notes of the topography and hydrography between St. Paul, Minn., and Brownsville, Minn. This reach is covered by 33 field plats, all of which have some completed work on them. There are 12 plats entirely completed, and 21 plats which are about nine-tenths completed as a whole. Soundings have been platted for a distance of about 25 miles from near Brownsville northward. Plats of the low-water survey from Vicksburg to Donaldsonville were completed and blue printed. The field notes of the surveys of the crevasses of 1897 were platted.

A profile covering the river from Cairo, Ill., to Fort Jackson, La., and showing the high waters of 1882, 1892, 1897, and 1898, and the low water of 1895, was prepared.

The level notes pertaining to the elevations of gauge zeros for the several inspections have been reduced and the corrections deduced.

The precise level notes covering the field work of 1897-98 from Baton Rouge, La., to Port Eads jetties have been reduced and the results are being checked and tabulated for publication. The Biloxi tide-gauge record has been reduced and tabulated down to April, 1898.

The low-water discharge measurements of 1897 and the high-water discharge measurements of 1898 have been reduced and tabulated for publication. All of the discharge measurements made during 1895–1897 were tabulated and printed.

The current gauge records have been corrected where inspection has developed errors in elevation of gauge, and monthly reports have been issued. The final results have been tabulated and the pamphlet of stages for 1897 has been printed and issued. The hydrographs for 1897, in 3 plates, have also been platted, drawn, and blue printed. Tabulations have been prepared showing highest and lowest stages and dates of same. A tabulation has been prepared showing yardage and cost of levees below Cairo, Ill., to December, 1897.

Monthly reports of operations of the secretary of the commission have been prepared and printed with the reports of district officers.

The proceedings of sessions 71 and 72, Mississippi River Commission, have been printed.

Descriptions of bench marks and their elevations from Arnolds Landing, Ill., to St. Paul, Minn., were prepared and printed.

MAPPING AND PUBLICATION OF MAPS AND CHARTS.

Work on the detail charts of the general survey of the river has been continued. Charts 150, 151, 152, 153, 154, 155, 156, and 157, scale 1:20000, covering the river from Davenport, Iowa, to Arnolds Landing, Ill., a distance of 82 miles, have been completed and published. Charts 158, 159, and 160 are also completed, and 161, 162, 163, and 164, extending up to Glen Haven, Wis., about 650 miles above Cairo, are about two-thirds done.

Inch-mile sheets 121, 122, 123, and 124, extending to a point 597 miles above Cairo, Ill., have been completed, and sheets 121 and 122 have been published. Sheet No. 3 of the Upper Alluvial Valley map has been completed and progress has been made on sheet No. 4.

PLANT AND OUTFIT PERTAINING TO SURVEYS, GAUGES, AND OBSERVATIONS.

The steamer *Patrol*, survey boat *Illinois*, and fuel barge and plant belonging to the same have been in use on the survey between Brownsville and St. Paul, and the low-water survey between Scot Bluff and Carrollton. On completion of the low-water survey the *Illinois* was left in care of a watchman at New Orleans, and the *Patrol* and fuel barge were used by the precise level party between New Orleans and Port Eads, La.

The *Patrol* and fuel barge were loaned to Maj. James B. Quinn from March 22 to April 23, 1898, for use in making a survey of Southwest Pass.

On April 23, 1898, the survey boat *Illinois* and outfit was loaned to Maj. James B. Quinn to be used as quarters for a discharge party stationed at Head of Passes, Louisiana. This boat is still in his hands.

The *Patrol* and fuel barge reached New Madrid on May 7, 1898, where she is now being cared for at the dredging fleet.

Only minor repairs have been made to this plant during the past year. The *Patrol* needs thorough painting throughout and also needs considerable work in the way of minor repairs to machinery.

The steamer *Search* has been used for discharge work, gauge inspection, and also for making surveys in connection with dredging. Minor repairs have been made to hull and machinery and the boat has been repainted. She is now on her way up the river completing the inspection of high-water gauges.

The work from St. Paul northward lies above the falls of St. Anthony, hence does not admit of using any of the above floating plant. A complete camp equipment has been purchased for the use of the survey party. This will be moved from point to point by means of wagons, and also, where practicable, with skiffs.

Respectfully submitted.

J. A. Ockerson,
Principal Assistant Engineer.

Capt. H. E. Waterman,
Corps of Engineers, U. S. A.,
Secretary Mississippi River Commission.

APPENDIX 1 D.

REPORT OF ASSISTANT ENGINEER THOMAS MIDDLETON ON DESIGNING, CONSTRUCTION, AND REPAIR OF PLANT.

ST. LOUIS, MO., *May 16, 1898.*

CAPTAIN: I have the honor to submit the following report of work done under my supervision for the past year:

The work of this department consists of designing new plant, the preparation of drawings and specifications for same, the determination and oversight of repairs to dredging plant, and the active supervision of the construction of new and repairs to existing plant.

A description of the six dredges now forming the dredging fleet of the Mississippi River Commission, and of large and small tenders under construction, is appended, together with a tabular statement of the leading features and dimensions of each dredge, to facilitate easy comparison. (Plate 4.)

WORK OF THE YEAR.

Dredge Alpha.—During the dredging season of 1896 the *Alpha* had commenced to bear evidence of the hard work she had been called upon to do since her experimental career had terminated, and a careful examination of the machinery, made May 12, 1897, showed that the main pump was badly worn in the shell, and that runner, shaft, couplings, and bearings were entirely unfit for further work and beyond the stage of economical repair. The engine was found to be in somewhat poor condition and the valves needing adjustment, but nothing was radically wrong or beyond the reach of ordinary repairs. After mature consideration it was decided to throw out the Edwards pump and substitute one of different design to fit in the same place. The necessary plans and specifications were prepared, proposals issued May 19, 1897, and opened June 3, 1897. The contract was awarded to the Morris Machine Works, Baldwinsville, N. Y., for $3,574, including extra shaft, pump runner, and bearing. The pump should have been completed ready for work September 6, 1897, but was not finished until ten days later. The engine had meantime been put in thorough repair, the valves adjusted, and the other machinery thoroughly overhauled. When the dredge was ready, however, she met with further detention from being quarantined, owing to some cases of yellow fever having been reported at Cairo, and it was the 12th of October before she finally arrived at her destination at Medleys (30). The increased rate of speed at which the engines ran during the season and the increased output of the pump, together with the small amount of lost time due to repairs of pump bearings, shows the material improvement which this dredge has undergone, but at the same time the fact can not be overlooked that the single-suction pumps having the overhung runner will always require more frequent adjustment of bearings and be liable to cause more lost time while dredging than pumps of the double-suction type.

Dredge Beta.—This dredge was placed in the possession of the United States by special contract with Mr. Lindon W. Bates for the dredging season of 1896. At this time the dredge had not been formally accepted by the engineer officer in charge, owing to noncompliance with the terms of the contract relating to the draft, which had been limited to 4½ feet, but was exceeded by about 2 feet. During the latter part of December, 1896, plans were prepared showing proposed method of widening the hull with the view of reducing the draft, and making such other alterations as come within the province of the contractor to put the dredge in proper working condition. These plans were submitted to the Chief of Engineers, United States Army, January 20, 1897, who decided that the contractor should be called upon to undertake the work. Mr. L. W. Bates was notified to that effect, and in reply ordered his agent to instruct F. E. Lesourd to take immediate steps toward commencing the work of alteration. In compliance therewith Mr. Lesourd consulted with Capt. H. E. Waterman, accepted the plans proposed, prepared specifications, and issued proposals for doing the work March 5, 1897. The result was only one bid received, and that at a price much above the amount retained by the Government from the contractor, and it was considered too high to be entertained. On May 14, 1897, Mr. Bates made a proposition that the United States Government should accept the *Beta* in her then present condition, and that in consideration therefor he would forfeit all claim to moneys retained and still in the hands of the Government. In accordance with this proposition the Chief of Engineers, United States Army, recommended the acceptance of the dredge, and an agreement to that effect was entered into between Lindon W. Bates and Capt. H. E. Waterman, on behalf of the Government, under date of June 1, 1897. The *Beta* having thus become the sole property of the United States, new plans and specifications were prepared, embodying many other changes and improvements which had been deemed advisable by the dredge committee, but which were outside of the alterations chargeable to the contractor. This remodeling involved the following alterations and additions:

1. (*a*) The hull to be widened 9 feet on each side; (*b*) the round stern partially cut away and the new one made square, extended 6 feet, and raked; (*c*) the sides to be carried forward 36 feet beyond old bow, leaving a well between, for suction heads; (*d*) a cross girder built between ends of above projecting wings; (*e*) the poop deck to be cut down to level of main deck; (*f*) the push spud well to be cut out and the recess plated over; (*g*) the two spud wells at the stern to be cut out and one of them built in at forward end of dredge; (*h*) the forward bunker to be cut out and placed alongside the after one, thus making a double bunker between the boilers.

2. The forward battery of boilers to be turned around and moved ahead as far as possible, thus bringing the firing ends toward each other, with the coal bunkers between.

3. Ash chutes to be put through bottom of boat at convenient places near boilers.

4. The discharge pipes from main pumps to be removed from their position overhead and placed on floor of hold.

5. The heavy and complicated mechanical agitators at the bow of boat to be taken out and new suction heads with water-jet agitators substituted.

6. Two pressure pumps for supplying jets to be installed.

7. Two suction water tanks placed in hold, with four intake valves for same.

8. The water filters to be removed from after hold and placed in hold forward of main engines.

9. Pump for serving filters removed and placed between filters, and the system of piping remodeled.

10. Engine and gearing put in for stirring up the filter sand by power, instead of hand.

11. The six-drum hoist to be taken out and four single hoists substituted.

12. The three-drum hoist, formerly used for lifting spuds, not being required, to be discarded.

13. A steam lifting cylinder for raising spud to be put in.

14. Three large steam capstans for breasting lines to be put in.

15. The feed-water heater moved to make way for change in discharge mains.

16. The two feed pumps taken from hold and placed on deck, where they are much more accessible.

17. Additional chocks and kevils placed on deck.

18. A larger electric-lighting plant to be installed.

19. A machine shop to be located at stern end of boat and furnished with an auxiliary boiler and additional machine tools.

20. The roof of engine house to be raised to inclose the traveling cranes.

21. A cabin to be built with accommodations for a full double crew.

22. A complete system of steam syphons put in.

The general design embodying these alterations was approved by the dredge committee February 1, 1898, and proposals were issued for the widening of the hull and such other work as was involved and could be determined upon in advance. The bid of the Iowa Iron Works, Limited, Dubuque, Iowa, was accepted for the sum of $26,900, and contract made for the completion of the work, on May 14, 1898. The *Beta* was at this time lying at New Madrid, Mo., and the dismantling and removing of discarded machinery was at once commenced. The work of changing the position of the forward battery of boilers and the rebuilding of same was also proceeded with by an employee of the Heine Safety Boiler Company, the original contractors for these boilers. In the meantime the selection of a suitable place at which the work of enlarging the hull could be carried out was under consideration, and finally arrangements were made with Lieut. Col. William R. King, Corps of Engineers, United States Army, for the use of the Government dry dock at Keokuk, Iowa. As soon as the ice had moved out of the upper river the *Beta*, together with a floating workshop, was taken from its winter quarters in tow of United States steamer *Minnetonka*, and docked on April 9, 1898. The contractors were delayed in receiving part of the material for the work, but by the 24th of April they had installed a pneumatic drilling apparatus for drilling the holes required in the original hull and for ventilating the small spaces between the inner and outer bottoms in which the men had to work putting in and holding on rivets, and had also started gangs of men cutting out old parts which had to be removed and preparing for the new material. The shop work is being pushed rapidly forward and early shipments will be made.

In considering the best method of attaching the extensions to the original hull it was deemed advisable to leave the old work intact as far as possible and add the new sides as independent water-tight compartments. No attempt was made to continue the system of framing from the old to the new parts, but efficient connection was made by gusset plates to each floor and deck beam, a continuous angle stringer riveted through and through with old knuckle, and an outer strap or tie plate riveted independently to the bottom plates of old and new parts. The strains due to the buoyancy of new sides are transmitted to old hull by diagonals of steel channel bars and by transverse bulkheads. The extension of the bows serves the twofold purpose of added buoyancy and a guard for the suction heads. The cutting down of poop deck reduced weight and made that part of boat much more convenient, as the deck is now all one level. The change in the location of the discharge mains was undertaken as a matter of necessity. In the original arrangement these large pipes were but a few feet above the top of bunkers, interfering very materially with the work of coaling, and making the passage across the boat at this point almost impossible. Advantage was taken while making this change to drop the bend of mains below the water line in order to make a water seal while priming the pumps, instead of putting in a large and cumbersome valve, such as is often used for this purpose. The mains are spread apart as they pass through the stern compartment of dredge and issue through the hull in the right position for coupling the pontoon line, thus dispensing with the two swan-neck pipes hitherto required. Designs were prepared for the new suction heads, proposals issued, and on April 30, 1898, the contract for building same awarded to the Koken Iron Works of St. Louis, Mo., for the sum of $3,750 set up in place ready for work. These suction heads have been reduced to one simple mouthpiece for each pump, but the three branch pipe and telescopic elbows were retained, as the great extra cost and delay in time did not appear to be compensated for by any corresponding advantage. Each mouth is 19 feet long and has a wide entrance, curved outward on top and extended with a baffle plate to prevent sand from being carried past the mouth and deposited in cut, and together they will make a cut at least 40 feet wide at bottom. For loosening and agitating the sand in front of suction mouths, the water jet was adopted to replace the unnecessarily massive and cumbersome arrangement of gearing and cutters originally on dredge. A saving of over 30 tons of weight has been made on this one item alone.

On March 26, 1898, bids were called for two duplex, compound, or triple expansion pressure pumps, with outside packed plungers for serving the water to agitator jets. The award was made to L. M. Rumsey Manufacturing Company, St. Louis, Mo., April 25, 1898, for supplying two duplex triple expansion pumps of the Blake manufacture, for the sum of $2,734 each, with delivery June 24, 1898. These pumps are placed on forward deck, in the house formerly occupied by the 6-drum hoist, and are so arranged that they can be worked either high pressure, by taking live steam in low-pressure cylinder; compound, by admitting steam to intermediate cylinder; or triple expansion when steam is taken by high-pressure cylinder; the pressure of water in the jets being varied, as required, from 40 to 100 pounds per square inch by changing the steam supply to the proper cylinder. The cylinders are, respectively, 8, 14, and 24 inches diameter, with plungers 16 inches diameter and 15 inches stroke. The discharge water from pumps is conducted by 8-inch pipes to a header placed on the under side of suction mouths and distributed evenly along the face of cut through 1-inch nozzles spaced 24 inches apart. The suction heads are suspended from the same A frames and by the same wire-rope tackle blocks that were previously in use.

The two steam-hoisting winches and the two hauling-ahead winches, required to replace the old 6-drum hoist, were contracted for on April 14, 1898, with M. M. Buck Manufacturing Company, for the sum of $2,460, with delivery June 14, 1898. In general design these winches are similar to those in use on several of the present dredges, which have proved to be very satisfactory. In the same contract was included the steam-lifting cylinder and accessories for raising the spud anchor, and also the fair-leads for hauling cables, at a cost of $633. Complete working drawings for all the above were prepared and issued to the manufacturers.

A contract was also made with the Hyde Windlass Company, of Bath, Me., for three large capstans, with double engines having 6-inch cylinders and 8 inches stroke, and fitted throughout with steel gears and bronze worms, at a cost of $1,035.

An electric-lighting plant, consisting of a directly connected 15-kilowatts Western electric generator of 125 amperes, 125 volts, with a 7 by 7 inch vertical engine, switch board, and instruments complete, and additional lamps for cabin service, was supplied by Newbery & McLaren, St. Louis, Mo., under award made May 14, 1898, for the sum of $1,280, the wiring to be done when cabin is ready. The old search lights were repaired and used in the new installation.

Besides the work given out by contract, a considerable amount of day work had to be done, notably the remodeling of the pipe system involved in the various changes of machinery; the placing, securing, and piping of the new machinery; the fitting up of a new system of bilge syphons; the removal of all discarded machinery, as well as the building of the cabin, which it is contemplated to do by hired labor.

Dredge Gamma.—At the date of last annual report the dredge *Gamma* was undergoing official tests. The contract for the *Gamma* with John S. George and Howard P. Eells, receivers of the Bucyrus Steam Shovel and Dredge Company, of South Milwaukee, Wis., was for the sum of $85,530, and required the completion of the dredge by March 29, 1897. An extension of time for sixty days was granted on account of high water, and it was not until April 26, 1897, that she left Jeffersonville, where she had been built, and, arriving at Cairo, was further detained until the water had lowered sufficiently to admit of her passing under the bridge. On May 27, 1897, the *Gamma* was delivered to the engineer officer in charge, at East Cairo, Ky., and later was taken to Arsenal Island, St. Louis, Mo., where she underwent the official tests for capacity and efficiency, beginning June 19, 1897, and terminating August 17, 1897. The early attempts to run the pumping machinery at its full capacity failed, from the difficulty of keeping the crank pins and main bearings cool, and finally resulted in a loose crank pin. The contractor had a new one of somewhat larger size put in and the bearings overhauled, and eventually succeeded in running up to contract requirements. The results of the tests demonstrated that this dredge may be counted on in the field for an average of 1,000 cubic yards of sand per hour, delivered through 1,000 feet of pipe, when developing 475 indicated horsepower, running 160 revolutions per minute, with steam at 140 pounds pressure. The *Gamma* was accepted after the contractor had made alterations and repairs which the tests had shown to be requisite for placing the dredge in proper working order and the due fulfillment of the contract, and was transferred to the dredge fleet at Cairo. During the dredging season the *Gamma* has done efficient work; can be easily handled on account of her small size; is economical in running; easy to maintain steam, but has a tendency to get hot bearings, which calls for extreme vigilance on the part of the engineers. The only serious interruption to her continuous dredging arose from the breaking of the cast-iron flanges which connected the suction pipes to pump at forward bulkhead, causing a delay of eleven days for repairs.

Dredge Delta.—At the end of June, 1897, the dredge *Delta* was completed and ready for testing. The contract for this dredge, with the New York Dredging Company, by George W. Catt, president, New York City, was for the sum of $124,940, and required the completion of the dredge by May 25, 1897. An extension of time for thirty days was granted by the Chief of Engineers, United States Army, on account of high water. On July 4, 1897, the *Delta* was taken to Arsenal Island and run by the contractor for a few days preparatory to the beginning of the official tests, which commenced July 9, 1897, for endurance. The machinery in general ran fairly satisfactorily, though some weaknesses were developed, and on July 28, 1897, a gear wheel of the agitator machinery was broken, but as a spare one was on hand no serious delay occurred. The results of the endurance test went to show that some difficulty would be experienced with the agitator machinery, owing to the liability of drift becoming entangled in the sprocket-chain gear. This occurred several times during the test, with the result of bending gear shaft, breaking bearings, and damaging the suction frame. The main engine and pump were run at contract requirements, and the final examination showed damage to high-pressure cylinder from broken packing ring; a weakness in low-pressure piston rod; considerable, but not abnormal, wear in the pump-shaft bearing, and great wear in the bearings of agitator shaft. These defects were remedied, as far as possible, after the tests were concluded. The capacity tests began August 2, 1897, and were continued until the 11th, the results showing that this dredge may be taken to have a field capacity of about 1,200 cubic yards of sand per hour through 1,000 feet of pipe, when developing 1,000 indicated horsepower, running 150 revolutions per minute, with a steam pressure of 160 pounds. In economy, as measured by the quantity of sand per I. H. P. per hour, according to the tests shown in plates Nos. 21 and 22, the *Delta* does not compare favorably with the *Gamma*, the former showing 1.62 cubic yards against 3.28 cubic yards for the latter. This would go to show that the mechanical agitator in this instance is not as efficient as the water jet for loosening the material to be pumped, though some part of the difference may be accounted for in the arrangement of the suction pipes and the inferior shape of the suction mouth. This dredge was accepted after being put in thorough repair, and was transferred to the dredge fleet at Cairo. The history of the dredging season on board the *Delta* is a record of stoppages and mishaps, more or less serious, connected in great measure with the agitator machinery. This mechanical device, consisting of a series of revolving tines similar to cultivator blades, placed on a transverse shaft over the mouth of suction, appears to have been especially designed to pick up every bit of drift or snag coming within its range and jamming them into the mouthpiece, framing, and chain, to the utter frustration of continuous dredging. Such an arrangement of cutters might prove satisfactory in some material, but in sand it is a costly and cumbersome substitute for the water jet; in gravel it might possibly pay the cost of running; in clay it would clog and become a revolving cylinder, effectively blocking the suction mouth, and in snaggy ground experience has proved its utter failure. It is believed that a well-designed suction head with water-jet agitator would increase the capacity of this dredge to about 1,500 yards of sand per hour; at the same time it is considered advisable that the dredging fleet should have at least two of its boats fitted out with some effective mechanical means of attacking compacted material, too hard for the action of the water jet, if such a machine can be devised—one that will work reasonably well under all the conditions met with in Mississippi dredging.

Another source of delay with the *Delta*, during the working season, was the changing of pump shaft and bearing, owing to excessive wear due to overhanging weight of runner, a condition incidental to the single-suction pump. Experience has demonstrated that these bearings can not be expected to remain in workable condition for more than five or six weeks, and if changed once a month it would be still better, and hence the question arises as to the relative advantages of the two classes of pumps, viz, the double suction, with pump runner carried in center of shaft between two bearings, and the single-suction pump with the runner overhanging its bearing. Another season of dredging will give opportunity for forming a more definite opinion on this matter.

Dredges Epsilon and Zeta.—At the close of June, 1897, the construction of the dredges *Epsilon* and *Zeta* was well under way. The contract for these dredges, made with the Springfield Boiler and Manufacturing Company, of Springfield, Ill., by Christopher C. Brown, president, for the sum of $102,000 for the *Epsilon* and $106,000 for the *Zeta*, required the completion of both dredges by October 6, 1897. At that date, however, the cabin work had just commenced, and though the machinery was all on board the piping and minor details were very incomplete. An extension of time for six weeks was applied for on account of the high water having interfered with the building of the hulls, and the excessively hot summer delaying the progress of the outdoor work. This extension was granted by the Chief of Engineers, United States Army. The hulls of the *Epsilon* and *Zeta* were built at Grafton, Ill., and were launched, the former August 4 and the latter August 25, 1897. The work of putting in the machinery and building cabins was pursued at the same place until November 22, when the dredges and pipe lines were removed to Cairo in a still unfinished condition. Work was continued at this point until the beginning of January, 1898, when they were declared ready for testing. The Government outfits were put on board, a final inspection made, the contractor's preliminary test of machinery was run, and the dredges accepted for official tests January 6. For this purpose double crews were shipped on each dredge and the whole outfit was towed down to New Madrid, Mo., by the United States steamer *Minnetonka*, this vicinity having been selected as the most convenient dredging ground available. By January 10 the dredges were in position and endurance tests begun, but they were subjected to interruptions from rising water, flow of drift, and wind storms. The main engines had been started at 160 revolutions per minute, and this rate was increased gradually to 180 revolutions, at which speed the fly wheels began to give trouble, the keys loosened, and set screws broke, and finally the hub of one wheel was found to be cracked. A new wheel was put in and additional keys used in all wheels, but an attempt to run the engine at the contract speed of 200 revolutions was attended by such a springing of the shafts as to be dangerous, and resulted in the breaking of one of the shafts of the dredge *Zeta*. An investigation of the cause led to the conclusion that, although the engines had shown a perfect running balance for a speed of 200 revolutions when on a solid floor in the shop, the changed condition of the foundation in the boat, which is necessarily elastic, affected that balance in such a way as to cause the destructive vibrations noted. The remedy for this trouble was thought to lie in making smaller and lighter fly wheels, and the contractor was called upon to make the change. In the meantime the stage of water had risen so high as to render dredging impracticable, and the dredges were tied up with the fleet February 14, to make necessary changes and repairs. The new fly wheels were in place by March 12 and the dredges were at once taken out, and after a five hours' speed test at 200 revolutions, which proved satisfactory, the capacity tests were commenced. The result of these tests with the *Epsilon* shows that she may be counted on for about 1,700 cubic yards of sand per hour, delivered through 1,000 feet of pipe, when developing 740 I. H. P., running at 180 revolutions, with steam at 155 pounds pressure. The average quantity of sand delivered per I. H. P. per hour was 3.388 cubic yards, being very nearly identical with that delivered by the *Gamma*, which was 3.28 cubic yards per I. H. P. These dredges have pumps of very similar design, and both have water jets served by centrifugal pumps with water at about 14 pounds pressure. The dredge *Zeta*, which was fitted with a mechanical agitator, did not pass the ordeal of testing so satisfactorily. The test of running at 200 revolutions was made successfully on March 18, 1898, and the capacity tests commenced on the 21st. The record of these tests is a record of stoppages to put in new "shearing pins," a device intended to prevent the agitator from being broken when coming in contact with snags or other obstructions, and so successful was it in this regard that it was difficult to run off a test without having to shut down to put in a new pin. The performance of this agitator was considered so unsatisfactory that it was deemed inexpedient to take the field relying solely upon its help to loosen material for the pump, and an arrangement was made with the contractors by which they would supply a jet pump and engine with all necessary connections and material for same, the placing on board and work of erection to be done by the dredge crew. The results of the tests of the *Zeta* (which is a duplicate of the *Epsilon*, with the exception of the agitators) show a decided diminution in the quantity of sand delivered per hour, which may be accounted for by the difference in the efficiency of the agitators; the average of five tests of the *Zeta* being 1,364 cubic yards and of the *Epsilon* 2,553 cubic yards of sand per hour. A comparison of the quantity of sand per unit of I. H. P. delivered by the *Zeta* and *Delta*, respectively (both having mechanical agitators), shows an equality almost as marked as in the case of the dredges with water-jet agitators noted above.

At the conclusion of the tests, a thorough examination of all the machinery having been made and same found to be in good condition, the dredges were accepted, subject to certain small matters of repair and alteration being completed by the contractor.

Pile sinkers.—In June, 1897, plans and specifications were prepared for a pile sinker, hull and leads, and advertisements were issued inviting proposals on same, constructed (1) of all wood, (2) of all steel, and (3) wood with steel leads, which resulted in a contract being made with the Cincinnati Marine Railway Company for the construction of one hull and leads of wood for $1,465. The great difference in the price of steel hulls over those of wood did not warrant the selection of the former material in this particular case. This boat was delivered at Cairo the latter end of August and was taken down to Point Pleasant with dredge *Beta*, where the boiler and machinery, which had been transferred from the first and second districts, were erected on board, and the pile sinker completely fitted out with cabin and all accessories. In February, 1898, plans and specifications were again prepared for pile sinkers and contract made with the Cincinnati Marine Railway Company for four hulls and leads, to be constructed of wood, for $1,684 each, delivery to be made July 25, 1898.

Hydraulic piles.—During the past much trouble has been experienced with the tubular piles furnished by contractors from the fact that they are too light, are easily bent, and are difficult or impossible to repair. A new design was prepared which is much stronger than those in general use by the fleet, and which, it is anticipated, will enable the piles to be repaired at comparatively small cost should they get bent by passing boats or tows, instead of becoming utterly useless, as is the case at present. A contract was made for 20 piles of this design, at a cost of $140 each, and they will be thoroughly tested during the coming season.

Small steam tenders.—General plans and brief specifications were prepared in May, 1897, for small steam tenders. Advertisements were issued inviting proposals for one, two, or three such boats, constructed (1) of all wood, (2) composite or steel framing with wood sheathing, and (3) with steel hull and wood deck. On bids being received it was decided to order one boat only, with steel hull, and a contract was made with the Iowa Iron Works, Limited, Dubuque, Iowa, E. N. Dickey, president, for $7,080, requiring delivery of boat November 3, 1897. Little progress was made with this contract until the beginning of October, owing to the delay in receipt of the steel for hull. From that time work progressed rapidly and the boat was launched November 25, 1897, but it was impossible to complete the work before navigation closed and the *Vulcan* was frozen in for the winter. The contractor, however, cut the ice around the boat and the machinery was tried sufficiently to warrant the acceptance of the boat, conditionally upon certain small details being finished before she should leave Dubuque. On the opening of navigation again the *Vulcan* was brought down to St. Louis March 30, 1898, and made a trial trip next day, running well and making a speed of 6.60 miles per hour upstream and 13.52 miles downstream, with engines averaging 27 revolutions and with steam pressure 180 pounds per square inch, after which she was sent down to New Madrid to join the fleet. During February and March of 1898 a more complete set of designs and specifications was prepared for three small tenders of the *Vulcan* type, but with such improvements in the general arrangements of boilers, cabin, and machinery as was deemed advisable; and bids were invited and opened April 16, with the result of the contract being awarded to M. A. Sweeney Company, Jeffersonville, Ind., for $23,247, delivery to be made September 10, 1898.

Large steam tenders.—Toward the close of 1897 the designing of the large steam tenders required for service with the dredges was taken in hand, but considerable delay was experienced, owing to the death of the draftsman who was at work on the plans and the difficulty of readily securing the services of another expert with sufficient experience in the class of boats required. By March, however, a complete set of plans and full specifications were prepared and proposals issued, to be opened May 27, 1898.

New dredge.—The designing of another dredge, the seventh of the fleet authorized by resolution of the commission, seventy-first session, July 22, 1897, was taken in hand, and preliminary plans and specifications for a self-propelling dredge of same capacity as *Epsilon* and *Zeta* were submitted and approved, with instructions to get out full details. This work has been accomplished, and a set of 17 sheets of drawings and full specifications have been made.

Repairs to plant.—During the dredging season of 1897–98 the steamer *Minnetonka* struck a snag near Gold Dust, Tenn. (156), tearing a hole in the bottom, and was sent to St. Louis for repairs. She was hauled out on the Carondelet ways, the necessary repairs effected, and the boat returned to the fleet October 8, 1897. This boat also broke a piston and knocked out a cylinder head, cracking the cylinder at the same time; repairs were made, and later it became evident that the cylinder was in a dangerous condition, so a new one was ordered (but not put in at the time). In April, 1898, the *Minnetonka*, after taking the *Beta* to Keokuk, was detained at St. Louis for the new cylinder and other needed repairs. The casing and breeching of boilers was in a very dilapidated condition, and when the boilers were stripped an examination showed so many cracked rivet holes and badly corroded plates that new boilers were considered necessary. Specifications were made for this and also for other needed repairs and bids invited for same, and a contract made with John Rohan & Sons Boiler Works Company, St. Louis, Mo., to furnish, erect, and build in four new boilers for $2,937, the casing and breeching having previously been awarded to same contractor for $395, the whole to be completed by August 2, 1898. In the meantime the new cylinder is being put in and other repairs done to the machinery and pipes. The roof is to have new canvas throughout, and the forward deck guards are to be renewed and the joiner work generally overhauled and put in order. This boat is also being fitted with the electric-light engine and generator taken from the dredge *Beta*, the old engine from the *Minnetonka* having been transferred to the *Beta* for driving the filter agitators. A contract was made with Crawley & Johnston, of Cincinnati, Ohio, for a steam steering gear, at a cost of $350, which will be fitted in place while the boat is at St. Louis.

Steamer Mississippi.—New boilers being required by the boat, plans and specifications were prepared, bids invited, and a contract made with John O'Brien Boiler Works Company, of St. Louis, Mo., for three new boilers and accessories, erected on board, built in and finished and tested under steam, for $2,740, to be completed July 15, 1898.

Besides these larger repairs the usual minor repairs and fitting out of the dredge fleet have been going on at the winter quarters, New Madrid, Mo., under the supervision of C. W. Sturtevant, superintendent of dredging.

Throughout the year constant supervision and inspection was maintained over all the work under construction by competent inspectors. The repairs in particular have had my personal attention. Periodical trips of inspection have been made to all new work, and also to the dredges during the working season and the testing operations.

DESCRIPTION OF DREDGES.

DREDGE ALPHA (PLATE 5).

During the spring of 1895 this experimental dredge underwent considerable modifications in the machinery and its experimental form was changed for one of everyday business. The crew were accommodated with a habitation on board and their wants provided for by ample kitchen requisites. This dredge, the forerunner and the smallest of the fleet, is regularly doing her share toward keeping navigation open during low-water season.

The dredge *Alpha* is 140 feet long, 36 feet wide, and 8 feet deep. The hull is built of wood, and is divided into 11 compartments by two longitudinal and three transverse bulkheads. A well or recess 30 feet long and 12 feet wide is formed in the bow, in which the suction head for main pump is placed. Small guards are placed alongside of boilers to form an outside gangway, and the deck is extended aft beyond hull a distance of 8 feet over the rubber connection to discharge pipe. The forward part of main deck is occupied by the machinery; aft of this is the workshop, and beyond this adjoin the crew's mess room, bathroom, wash room, storeroom, and cold store. The cabin is 118 feet long and 30 feet wide, and contains office, officers' mess room, two spare staterooms, ten staterooms for officers, wash room, bathrooms and water-closet, kitchen and pantry, storeroom, and laundry, and, at after end, the crew's sleeping quarters. Above the cabin is a pilot house 10 by 12 feet, from which the movements of the dredge are controlled.

The pumping machinery consists of a 30-inch centrifugal pump, built by Morris Machine Works, Baldwinsville, N. Y., and was specially designed to occupy the place of the Edwards pump originally used on this dredge. The runner is 66 inches diameter and the shaft couples directly with the crank shaft of engine, and an adjustable bearing is provided on the pump for taking up the wear in order to keep the shafts truly in line, much trouble having been experienced with the former pump in this matter. The pump is driven by the original Edwards engine, which is vertical compound noncondensing, with cylinders 15 and 27 inches diameter by 20 inches stroke, running about 150 revolutions per minute. The capacity of pump is estimated at 500 cubic yards per hour. The suction is 7 feet 6 inches wide at mouth, contracting gradually to a pipe 30 inches in diameter, and enters the dredge by means of a radial joint, which admits of the suction head being raised or lowered to the desired depth. Inside the boat the suction pipe is continued aft and connected to pump by a flexible joint of 8-ply rubber. The discharge from pump is led by an elbow to the starboard side compartment, and is conducted aft and through stern of dredge, where the floating pipe line is connected by means of a 6-foot length of rubber hose. The sand in front of dredge is loosened or agitated by 6 jets which issue from 2½-inch nozzles distributed along front of suction head, the water being supplied at 10-pound pressure by a Reynolds helical pump with 48-inch runner, driven at 350 revolutions per minute. The engine is of the vertical compound noncondensing type, having cylinders 8 and 16 inches diameter by 12 inches stroke, placed tandem, with low-pressure cylinder on top. There are 3 cranks placed at 180 degrees apart, 2 coupled to the low-pressure piston rods and 1 to the high pressure. It is somewhat difficult to keep this engine in good running order at the high speed and continuous running necessary for the pump. The suction is taken from the port side of dredge through a 15-inch pipe and delivered by two 8-inch pipes which lie on top of suction frame and connect to pressure chamber, the movement of suction head being provided for by bellows joint connections. The raising and lowering of suction frame is accomplished by wire-rope tackle and sheaves, which are carried by overhead gallows frames erected on sides of well at the bow of dredge. The hoisting is done by one of the bow or hauling winches. The bow winches for hauling ahead are placed on each side of well. These winches have pairs of 8 by 8 inch horizontal engines geared about 200 to 1 by worm gear on first and spur gear on second motion. The drums are 34 inches diameter and hold 1,200 feet of ⅞-inch wire rope. The cables are led by means of sheaves to a convenient position at bow of dredge. The breast lines are handled from gipsy heads on bow winches led through sheaves on deck, and a small steam winch is placed on after deck for use in connecting pipe line.

Steam is supplied to the machinery by two batteries of boilers of the usual Mississippi River type, each battery having two boilers 42 inches diameter and 28 feet long, containing five 10-inch flues, and giving a total heating surface of 1,800 square feet. The grates are each 8 feet wide and 4½ feet long, equal to a total grate area of 72 square feet. The boilers are provided with the usual steam and mud drums and feed-water heater. Two feed pumps, with outside packed plungers, 6 inches diameter, cylinders 10 inches diameter and 10-inch stroke, which is also used for supplying water to the journals.

The electric-light machinery is placed abaft the boilers on port side and consists of a 6 by 10 inch horizontal engine belt connected to a 9-kilowatt Westinghouse generator. This machine operates 1 search light, which is mounted on top of pilot house, 2 arc lights at bow and 1 at stern, and 70 incandescent lights distributed throughout the boat.

The machine shop is furnished with a lathe, drill press, emery grinder, and blacksmith forge, all driven by a small horizontal engine, supplied with steam from the auxiliary boiler.

The floating pipe line consists of 30 sections, each 33 feet long, which are coupled together by short pieces of 8-ply rubber hose secured by iron bands, and also by pin-jointed coupling bars riveted to each end of pipes, for the purpose of relieving the rubber from the strains to which the pipe line is subjected. In the case of 15 sections the air chambers are built from the sides of the discharge pipes and extend over the top, giving about 5 inches of free board when pumping water only. The other 15 sections have the air chambers entirely independent, being simply cylindrical tanks, placed one on each side of discharge pipe and secured by cast-steel saddles and chains. A gang plank is fitted on top of pontoons to provide easy access to all the joints. A baffle plate is attached to the last pipe of the line to take the reaction of the issuing stream of water and prevent the pipe line from kinking.

This dredge takes a double crew of 43 all told.

DREDGE BETA (PLATES 6 TO 8).

The *Beta* is now (after alteration of 1898) 214 feet long, 58 feet wide, 6 feet 10 inches deep at sides, and 7 feet 3 inches deep at center. A forecastle stands 3 feet 8 inches above main deck, and wings extend forward on each side of hull a distance of 36 feet from bow, leaving a well 36 feet wide at hull and 42 feet wide at nose, in which the suction heads are placed. The wings are connected at the forward ends by a girder which carries the head sheaves and serves as a gangway. The hull is built entirely of steel and is framed transversely, the floors of the old part being made of 12-inch I beams and the frames of 3 by 4 inch angle bars spaced 24 inches apart. Eleven keelsons of 12-inch I beams runs fore and aft over floor beams. The inside water bottom is laid on top of keelsons and forms the floor upon which the heavy machinery and boilers rest. The extension sides which are built on hull to reduce the original draft have floors of 5-inch Z bars, frames and deck beams of 3 by 4 inch angles, braced with stanchions of channel bars every frame, diagonals every fifth frame, and bulkheads every 30 feet, but there is no inner bottom plating. The hull is contracted in width at bow and stern and each end has a good rake to give ease in towing.

The cabin of the *Beta* is 168 feet long, 32 feet wide as far aft as mess rooms, where it widens to 39 feet as far as crew's quarters, where the width is 46 feet. The forward cabin, which reaches to the engine room, contains office, officers' sitting rooms, 2 spare state rooms, 10 rooms for officers, wash room, bathroom, and closets. Immediately aft of the engine room the kitchen is located, with mess rooms on each side and pantry, and then comes the after cabin, containing cold store, laundry, crew's bathrooms, storeroom, and 12 rooms for crew.

There are two sets of pumping machinery on this dredge, either one of which can be worked independently of the other. The pumps are of the double suction centrifugal type with discharge on top. The runners are 7 feet in diameter and are hung centrally on their shafts, which have substantial bearings to carry their outer ends. The pump shafts are directly connected to crank shafts of engines by rigid couplings. This arrangement has, so far, proved satisfactory. Each pump is driven by a vertical triple expansion condensing engine with cylinders 20½ inches, 33 inches, 38 inches, and 38 inches diameter, respectively, and 24 inches stroke, running 140 revolutions per minute and developing an average of 925 indicated horsepower. The engines and pumps are set upon heavy subbases, which makes them self-contained. The average capacity of each pump may be taken at about 1,500 cubic yards of sand per hour. The jet condensers are of the Worthington independent type with duplex air pumps 19 inches diameter, steam cylinders 14 inches by 15 inches stroke, and are placed alongside their respective engines. The total width of the two suction heads is 38 feet 8 inches, which would excavate a channel at least 40 feet wide at bottom. The mouthpieces are of such form that the sand which is thrown up by the water jets falls within the influence of the suction current, and a screen plate is raised above the entrance to prevent, as far as possible, any of the sand being carried past the mouth and deposited again in the dredged channel. From each head, the suction water is conducted by three 19½-inch pipes, which enter the bow of dredge by radial bends of heavy copper, working freely and without any attempt at packing in cast-iron socket pipes secured on the inside of boat, and which in turn are connected by a three-branch pipe to the suction main 33¾ inches diameter leading to the pump, where it is again divided and enters each side of pump casing at the center. The discharge pipes are 33 inches diameter, and, on leaving pumps, converge toward the center line of boat and dip to the floor, along which they pass between the boilers and emerge from the stern at a distance apart of 11 feet.

The sand in front of suction heads is loosened by means of 18 jets issuing from 1-inch nozzles placed at the lower end of mouth and supplied with water under pressure of from 40 to 100 pounds, according to the nature of the material to be dredged. The pumps used for this purpose are placed on forecastle deck and are duplex triple expansion condensing, with cylinders 8 inches, 14½ inches, and 24 inches diameter, respectively, and two pump plungers 16 inches diameter by 15 inches stroke. The engines are so arranged that live steam can be admitted to each of the cylinders according to the pressure of water required. The exhaust of these engines is connected with the condensers of the main engines. The suction water is taken from tanks placed in hold of dredge immediately below the pumps, the water being admitted through bottom of boat by 14-inch pipes provided with shut-off valves. The tanks are also provided with brass wire screens.

The suction heads are suspended from A frames projecting from bow of dredge, and are raised and lowered by means of separate winches and wire-rope tackle. The winches are driven by pairs of 7 by 7 inch horizontal engines geared 32 to 1, and have grooved drums 42 inches diameter upon which the hoisting ropes are wound. The engines are fitted with link motions and winches with locking brakes to prevent the load from overhauling the engines. The bow winches for regulating the forward advance of the dredge into cut are placed well forward on each side of the forecastle deck. They are driven by pairs of 7 by 7 inch vertical engines, geared 412 to 1 and 90 to 1 by worm and spur gears in such a manner that the rate of advance can be regulated as desired, from 1½ to 36 feet per minute. The winding drums are 48 inches diameter and will hold 1,200 feet of 1 inch wire cable. The cables are led forward to guide sheaves on bow girder and thence to hydraulic piles set at head of intended cut.

Three large steam capstans, driven by pairs of 6 by 8 inch horizontal engines, are provided for handling breast lines, the one at the stern serving also for use in placing and coupling the pipe lines.

A spud anchor of oak, 24 inches square and 40 feet long, is used for holding the dredge when changing lines or in any case of necessity. It is placed in a well at the forward end of dredge and is raised with a steam cylinder 18 inches diameter and 6

DREDGE DELTA (PLATE 10).

This dredge is 175 feet length of hull and 199 feet over the bow fender, 38 feet wide, and 8 feet deep. The hull is built entirely of steel, and is framed transversely; the floors are 6-inch Z bars and the frames 3 by 4½ inch angles, spaced 22 inches apart. The machinery being almost entirely carried on deck, there are no keelsons, but the hull is stiffened by two fore and aft and five transverse bulkheads, making 18 watertight compartments, and also by rows of intermediate stanchions attached to angle-iron stringers. The bow and stern have small rakes, and a fender is built around the suction heads at bow, the top of which is flush with main deck and forms a gangway. The deck house is 155 feet long and 31 feet wide, the rooms for winding machinery, main engines, and boilers being the full height of cabin, and the operating room extending over the forward deck. This room is also used for the office, the officers' staterooms, bathroom, and closet occupying the adjoining section. There are eight staterooms, storeroom, and wash room at sides of engine room, and aft of this and over the filter room are the kitchen and mess rooms; the crew's quarters are on main deck in the filter room, the starboard side being occupied by fire pump and workbench.

The pump on this dredge is of the single suction type, and is set athwartship, thus bringing the suction pipe and shaft on the fore-and-aft center line, while the discharge is from the bottom, inclined upward and toward the starboard side. The pump is fitted throughout with lining plates, which can be renewed when worn. The runner is 7 feet diameter, with five blades, and overhangs the bearing; the shaft is incased in brass, and runs in a babbitted sleeve bearing, and is provided with adjustable collar to take the thrust. An intermediate shaft connects the pump with crank shaft of engine. The pump is driven by a vertical compound-condensing engine of the marine type, with cylinders 22 and 48 inches diameter and 24 inches stroke, the high pressure being fitted with a piston valve, on the inside of which the cut-off valve is placed, and is adjusted from the outside with a right and left hand screw, same as in the Meyer cut-off. The engine and pump are placed in a pit below the level of deck, and are carried on a foundation of fore-and-aft and transverse girders. These engines run at about 150 revolutions per minute, and develop an average of 1,000 I. H. P.; the field capacity of the pump may be taken at about 1,200 cubic yards of sand per hour. The condenser is of the jet independent type, worked by a single air pump 18 inches diameter, with steam cylinder 12 inches diameter and 34 inches stroke. A heavy I beam is placed over the engine and pump, upon the lower flange of which a traveling carriage is mounted, carrying chain blocks for lifting the heavy parts of machinery.

The suction head has a total width of 33½ feet, and consists of four separate mouthpieces tied together by I beams and bracing into one frame, which swings upon trunnions carried by bearings riveted on bow of dredge. Each mouthpiece is gradually contracted to 17½ inches diameter and connected in pairs by short pipes to Y's, which in turn connect to elbows 24½ inches diameter, having their centers coinciding with the centers of trunnions and their flanges fitting into recesses in the face of stationary elbows which are secured to the bow of dredge. The swivel joint thus formed permits of the requisite movement for raising or lowering the suction head. From the bow two suction pipes 24½ inches diameter run aft to first bulkhead, where they are united by a Y into one pipe 34 inches diameter, which is connected to pump by a short section expanding to 38 inches diameter. The discharge pipe, 34 inches diameter, turns into the starboard compartment, and after passing by the engine pit converges to the center line of boat and issues from the stern at a height of 43 inches from bottom. In elevation the suction pipes are arranged so that water will just flow into pump, and the discharge so that the water is retained in pump at the water line, under which condition the pump will pick up the suction without the aid of primers.

This dredge is fitted with a mechanical agitator, which consists primarily of a series of revolving teeth placed in front of and above the mouthpieces. A steel shaft 6⅞ inches square is carried in bearings attached to the framing of suction head, upon which 22 spiders are clamped, each spider having four curved arms, on the ends of which are bolted teeth, shaped similar to cultivator blades, the alternate spiders being advanced one-eighth of a revolution to bring the teeth in line with the spaces of the others. The shaft is provided with renewable sleeves which run in the bearings above mentioned. The agitator is driven by a pair of horizontal engines with cylinders 12 inches diameter and 15 inches stroke, set upon a sliding bed frame and compound geared to a countershaft which is carried by bearings on the inboard end of suction frame. Sprocket chain gears are keyed on ends of countershaft and drive similar sprockets on agitator shaft by means of heavy chains of the link belt pattern 8½ inches pitch. A pair of steel links or coupling bars reach from crank shaft to countershaft, having babbitted bearings at each end, which permits of the free motion of shafts. On top of links the intermediate gear shaft is carried, thus maintaining a constant distance between each of the shafts, the entire engine being moved back and forth by the raising and lowering of suction heads. Consequent upon this movement of engine the steam and exhaust pipes work in stuffing boxes with telescopic joints. All pinions and sprocket wheels and chain are of steel. The ratio of gearing is 24 to 1 and the peripheral velocity of agitator teeth is from 60 to 150 feet per minute. The suction frame is arranged to dredge to a depth of 15 feet. The vertical movement of suction frame is effected by means of a double set of sheaves and wire-rope tackle, the head sheaves being carried by a derrick frame overhanging from bow of dredge and the fall led overhead to aft of gear house, where it passes downward to the hoisting drum.

The spud anchor is of oak, 24 inches square, and is raised by means of a wire rope reeved over a sheave on roof, led aft same as hoisting rope and down to spud drum.

The hoisting and hauling machinery is located between the main pump aft and the workshop forward. The starboard and port sides are driven independently by separate but similar engines, and the gearing also is in duplicate. The engines are pairs of horizontals, with cylinders 10 inches diameter and 12 inches stroke, set on deck and driving trains of gears connecting with the different drums. The spud and suction hoist are doubled geared 53 to 1, and the hauling winches are triple geared 370 to 1, with extra gears of a ratio of 53 to 1 for quick motion hauling in slack cable. The drums for spud and suction are 24 inches diameter and 24 inches long; those for hauling are 42 inches diameter and 42 inches long. The whole gearing is fitted throughout with Hill friction clutches and post brakes. A traveling crane is placed overhead, by which all this machinery can be handled.

The operating room is located forward of cabin and over the forward deck, and all the working handles connected with throttles, clutches, and brakes are grouped here, conveniently for handling.

Two power capstans are placed on forward deck for handling breast lines. They are driven by one double engine with 5-inch cylinders 8 inches stroke and worm gears, a lay shaft extending athwartship to the other capstan. A stern capstan of same size and power is located aft of boiler house for stern lines and floating pipes.

The steam plant of the *Delta* consists of four Heine water-tube boilers of 250 horsepower each, built in two batteries, each boiler containing 140 tubes 3½ inches diameter and 16 feet long, giving a total heating surface of 6,800 square feet. The furnaces are each 8 feet 10 inches wide and 6 feet long, giving a total area of 204 square feet. The feed water for boilers is passed through a Jewell pressure filter 7 feet diameter and 6 feet 9 inches high, with a capacity of 65 gallons per minute.

The sand is agitated by steam power, and a supplemental filter is provided for filtering the water used for washing out the sand bed in the main filter.

The two feed pumps are of the duplex pattern, with plungers 4½ inches diameter, steam cylinders 7 inches diameter and 8 inches stroke, located on port side of forward boilers. They are connected with filters and heater and have also a direct river connection.

A Wainwright heater 37½ inches diameter and 11 feet 4 inches high is used for heating the feed water and takes the exhaust steam from all the pumps and the winding and agitator engines.

The fire and service pump is of the duplex pattern, with plungers 5 inches diameter, steam cylinders 8 inches diameter and 10 inches stroke, and is located on starboard side of engine room. Besides the connections to fire mains, this pump supplies water for journals and for domestic purposes.

The electric-lighting outfit consists of a General Electric 4-pole generator of 9 kilowatts belt connected to a 7 by 9 inch New York Safety Automatic engine, and operates 1 search light at bow, 2 arc lights, and 100 incandescent lights.

The machine shop and forge occupy the forward compartment of deck house, and is furnished with a screw-cutting lathe and drill press, driven from the electric-light engine.

The floating pipe line consists of 20 sections, each 50 feet long, connected with flexible joints of rubber hose and pin-jointed bars, as before described. The air chambers are of a U-shaped section, flat on top and semicircular on bottom, 26 inches wide and 23 inches deep, and are tied together in pairs by five 3-inch angle-iron yokes, in which the 34-inch discharge pipes rest, being retained in place by their own weight and prevented from end drift by angle clips placed just outside of end yokes. On the last section of pipe a curved movable baffle plate is pivoted on projecting arms riveted to pipe, and can be moved to right or left at will by a lever working on a quadrant attached to pontoon and to which it is pinned when baffle plate is at the desired angle. This device has been found effective for deflecting the pipe line a considerable distance from the axis of channel.

The *Delta* is operated by a crew of 43, all told.

DREDGES EPSILON AND ZETA (PLATE 11).

The *Epsilon* and *Zeta* are sister dredges, alike in all points except the agitators, but as the *Zeta* will be fitted with water jets before beginning the season's work this difference will cease to exist. The following description will refer specifically to the *Epsilon* only:

This dredge is 157 feet long over hull, with a stern fender projecting 3¼ feet; the width is 40 feet and the depth is 7½ feet, with a draft of 46 inches. The suction well in bow is 32 feet long, 18 feet wide at bow and 22 feet wide at nose, the wings thus formed being tied together by a box girder 36 inches deep. The hull is built entirely of steel and is framed transversely; the floor beams are 12-inch channels; the frames are 3 by 4 inch angles, and deck beams 5-inch and 6-inch bulb angles, except the short beams at sides of engine and boiler pits, which are of 3-inch angles; the whole being connected by gusset plates at corners. The bilge knuckles are made of 4-inch angle bars. The frame spacing is 24 inches in the engine pit and 30 inches throughout the remainder of the hull. Ten keelsons of 15-inch I beams run fore and aft and are riveted to all floor beams, and form the floor upon which engine, pump, and boilers, etc., are set. There are five transverse bulkheads and two longitudinal at sides of engine and boiler hatches, making 11 water-tight compartments, flanged intercostal plates being fitted between floor beams and keelsons.

The deck house is 112 feet long and 33¼ feet wide, inclosing all the machinery; but the front of the house is made with removable panels, which are taken out when the bow machinery is working. The cabin is 109 feet long and 32 feet wide, with guards all around and a skylight running full length. The forward part contains the office, two staterooms and bathroom, officers' mess, staterooms, bath and wash rooms for officers; the kitchen, pantry, storeroom, and laundry are in the middle; and crews' quarters and mess room, with accommodations for 28 men, are placed aft. The bathroom, wash room, and closets for crew are placed aft on a half deck above boilers.

The main pump on the *Epsilon* is a 32-inch centrifugal, with double suction and bottom discharge, made by Morris & Co., of Baldwinsville, N. Y. The runner has 7 blades, 69 inches diameter, and is keyed on the middle of its shaft, which is fitted at each end with steel-flanged couplings, by which connection is made to crank shafts of engines. The pump is directly connected to a pair of horizontal tandem compound engines with 16 and 26 inch cylinders and 18-inch stroke, designed to run at 200 revolutions per minute. The engines have double crank shafts, and are fitted with automatic wheel governors, which regulate to within 2 per cent.; the high-pressure cylinder has a piston valve and the low pressure a balanced slide valve. The engine is of the inclosed or oil-bath type, and the lubrication abundant and complete; the frame is made hollow, and fitted with water circulation to absorb the heat should the bearings or slides develop a tendency to become heated. Each engine is fitted with a separator, and the cylinders have safety relief disks attached to the drain cocks, besides pop safety valves on top. These engines indicate 750 horsepower when running at 180 revolutions with 155 pounds of steam, while the field capacity of pump may be taken to average 1,700 cubic yards of sand per hour.

The total width of the two suction heads is 20 feet, which will make a cut 22 feet wide at bottom. The mouths are 36 inches high and contract to 24 inches a short distance in and are gradually reduced in width to 24 inches, at which point they are connected to the suction pipes, which enter the hull by means of radial joints attached to bow of dredge, similar to those on dredge *Alpha*, and are carried aft below deck, entering the pump by elbows on each side of casing, made in halves, for convenience of removing pump runner. The area of mouthpieces is reduced by the insertion of six lobes 7 inches wide, tapering to an edge at the back and leaving 7-inch spaces between. These lobes serve the double purpose of increasing the velocity at entrance and forming a screen, to prevent snags and drift entering the suction pipes. The two suction pipes are strongly tied together by diagonal bracing, and the heads are connected by flanges and the pressure chambers. The discharge main is 32 inches diameter and runs aft in the center of boat, emerging from stern at a height of 49 inches from bottom.

The water-jet agitators for loosening the material to be dredged are applied to this dredge. A pressure chamber is riveted to the under side of suction heads with ten 3-inch nozzles distributed along the face, which are supplied with water at about 15 pounds pressure by a centrifugal pump. This pump has a runner 49 inches diameter, with double disk and five curved water passages between them; the suction is 18 inches diameter and delivery 15 inches. The discharge is led through bow of boat, where it is fitted with a radial joint similar to the main pump suctions, and thence to pressure chambers on suction heads. This pump is driven by a vertical compound engine, marine type, with cylinders 12 and 22 inches diameter and 12 inches stroke, and runs at 200 revolutions, developing 125 indicated horsepower.

The suction heads are suspended from a gantry carried by A frames of latticed channels stepped on the keelsons. Wire-rope tackle blocks are used, and the hoisting is effected by an independent winch driven by a pair of 7 by 7 inch vertical engines geared 23.7 to 1. The drums are 42 inches diameter, grooved for rope. The engines are fitted with link-motion valve gear, and locking break for holding the load is fitted on second-motion shaft.

The bow winches for regulating the forward advance of the dredge into cut are placed on each side just aft of well, and are of the same general design as those on *Beta* and *Gamma*. The engines are 7 by 7 inches, vertical, geared 463 to 1 for slow motion and 70 to 1 for quick motion. The winding drums are grooved, 42 inches diameter and 42 inches long, and are fitted with brakes. The cables are led forward and pass over snatch blocks hung from gantry, and thence to hydraulic anchor piles set at head of cut. The operator's platform is placed just aft of the winches, and all the handles for working the winches are assembled here, as are also the gauges which indicate the work the pump is doing.

Three steam-power capstans, driven by pairs of 5 by 8 inch horizontal engines and worm gear, are provided for handling the breast lines. The after capstan is also used for coupling up the pipe line.

A spud anchor of oak 22 inches square, for holding the dredge in position, is located near bow of dredge and passes through a well built in hull. The raising is done by a winch similar to that used for the suction frame, except that the drum is 30 inches diameter and is driven by a friction clutch on main spur gear, by means of which the spud is tripped. When not in use the spud is held up by a pawl on the drum.

The steam plant of the *Epsilon* consists of two batteries of Mississippi boilers, three in each battery. Each boiler is 48 inches diameter, 28 feet long, and contains two 13-inch and three 11-inch flues, and is fitted with the usual mud and steam drums and arranged with independent steam and feed connections. The furnaces are 14 feet wide and 5½ feet long, giving a total grate area of 154 square feet, the total heating surface being 3,300 square feet.

The feed pumps are of the duplex outside-packed plunger pattern, with steam cylinders 8 inches and water cylinders 4½ inches diameter and 10 inches stroke, taking water from a tank in corner of engine room and passing it through a heater before entering the boiler. The fire pump is of similar make, but has steam cylinder 10 inches, water cylinder 5 inches, and 10 inches stroke, and is also used for the service tank, washing and filling boilers, etc.

The electric-light plant consists of a National generator of 12 kilowatts, directly connected to a 5 by 6 inch Ideal engine, running about 500 revolutions, placed in the machine shop, forward of engine room. This machine operates 1 search light at bow, 1 arc light at stern, and 80 incandescent lights.

The workshop is located on main deck, between winch room and engine room, and is furnished with 20-inch screw-cutting lathe, 25-inch back-geared drill press, 15-inch shaper, bolt and pipe thread-cutting machine, emery grinder, blacksmith's forge, with fan blower, and workbench.

The above machine tools are driven by an 8 by 8 inch vertical engine.

The auxiliary boiler is 42 inches diameter and 9 feet high, with submerged tubes, and is located in the stokehole, close to bunker. The steam connection is made to main line.

The floating-pipe line consists of 20 pontoons, each carrying a length of 50 feet of 32-inch discharge pipe. The pontoons are a segment of a circle in cross section, the deck forming the chord, with center of pipe 12½ inches below deck line, and are divided by bulkheads into 6 water-tight compartments. These pontoons are made to be unsinkable with any possible load of sand, and, with average pumping, have a free board of 6½ inches. The connections are of rubber hose with pin-jointed bars, as in the other dredges, and a fixed baffle plate is used on end of line.

The dredge will have a crew of 48 all told.

MECHANICAL AGITATOR OF DREDGE ZETA.

This agitator was designed with the view of retaining the suction heads in the same form as those on the *Epsilon*. The device consists of a reciprocating frame working in front of suction mouth and having a series of 8 vertical bars, each fitted with 5 teeth made of 1-inch-square steel. The agitator frames are hung from levers carried by brackets attached to suction heads, and are operated by a pair of horizontal engines with 10-inch cylinders, 14 inches stroke, single geared. Cranks are keyed on ends of main gear shafts and the motion transmitted to agitators by levers, links, and pitman rods.

LARGE STEAM TENDERS (PLATES 12 TO 16).

These boats are used for towing the dredges, floating pipes, and pile sinkers from bar to bar, for handling floating plant, or coaling, as may be required. Five tenders of this class are now under contract, to be built from the same lines and alike in all respects, except that one will have larger engines than the others, and will be assigned specially to tend the dredge *Beta*. The hulls are built entirely of steel and are 171 feet 6 inches long, 36 feet beam, and 5 feet 6 inches deep molded dimensions, with a draft of 48 inches when fully equipped. The hog-chain system has been omitted and the hulls made of sufficient strength to take all strains. The framing is on the transverse system throughout, the floor frames are of 3 by 2½ inch angle bars, continued up the sides to gunwale, and have reverse angles riveted on free edge which run up as far as the turn of bilge. The deck beams are 3-inch Z bars and connect to frames by gussets. The frame spacing is 18 inches throughout. The requisite strength of hull is obtained by bulkheads and internal bracing. There are 5 transverse bulkheads and a collision bulkhead, making 7 water-tight compartments; a longitudinal bulkhead runs on the center line from near the bow to transom and is riveted to skin plates on the bottom edge, dividing the floor frames, which are well secured to bulkhead by gusset plates. On each side of center there are two fore and aft truss frames; the inboard ones beginning at first bulkhead and the other with the model of boat, and running clear aft join the transom. The top and bottom chords are of 10 by ½ inch plates and 2½ by 2½ inch angles. and the lattice bracing is of 2½ by 2½ inch angle bars in double panels. The boats are built without guards and are fitted with oak nosings. The heads are so constructed as to dispense with the gallows frame bracing, and in order to keep the overhanging guards strong enough for towing purposes, the outriggers are formed by an extension of the frames and deck beams, substantially braced together and plated on the under side in continuation of the skin plating. The thickness of plating is five-sixteenths inch at bow and one-fourth inch generally throughout the remainder of hull, except keel strake, bilge strakes, plate sheers, and center-deck strake, which are five-sixteenths inch.

The forward deck is flush with nosing, the usual chocks being dispensed with, and independent sheave chocks and kevils of steel riveted to deck instead. The stack and towing knees are formed of continuous corner plates, to which the towing posts are bolted, backed by plate steel knees stiffened by angle bars, all riveted to the deck.

The cylinder and wheel beams are box girders, the long beam extending 24 feet aft and working into fantail as usual. Single wheel chains are used to steady the beams and prevent vibration, the beams themselves being of sufficient strength to carry the load.

The boats are fitted with two balanced rudders made of steel plate built upon stocks of 8-inch heavy tube; the tillers are made of flat eyebars braced together. A steam steering gear of the direct-acting type is used and worked by levers placed in close proximity to the pilot wheel, so that steering can be done by hand or steam at will.

Cabin accommodation is provided for a double crew of 35. The forward section contains the office, spare staterooms, officers' mess room and staterooms; the second section, separated by a passageway, contains the kitchen, pantry and storeroom, laundry, wash and bath rooms; while the third section, separated by an open gangway, is for the crew's mess room and quarters; and aft of this are placed the bath and wash rooms for crew. The pilot house is 13 feet square and is placed about the middle of the boat. A steam heating system is fitted throughout the boats.

The paddle wheel is 24 feet diameter and 24 feet long, with 16 buckets 34 inches wide. The engines have cylinders 22 inches diameter and 8 feet stroke, fitted with balanced valves and California cut-off.

The pitman rods are made of steel tubes trussed, instead of wood, and pistons and crossheads are of steel, and all the heavy cast-iron bed plates have been dispensed with in order to reduce weight to a minimum.

The boilers are six in number, set in two batteries; each boiler is 38 inches diameter and 30 feet long, and contains two flues 14 inches diameter. The three boilers of each set are connected by mud and steam drums, the latter 28 inches diameter and 11 feet long, fitted with internal dry pipes connected with main steam branches. The steam pressure carried is 200 pounds per square inch.

The feed pumps are of the vertical duplex outside-packed plunger pattern and are placed in front of boilers; the steam cylinders are 7½ inches diameter by 6 inches stroke, and plungers are 4½ inches diameter.

The fire pump in engine room is of the horizontal duplex type. This pump is connected with auxiliary boiler and is also used for washing decks and washing and filling boilers.

The boats are fitted up throughout with electric lights. One search light is placed on hurricane roof, one arc light forward on outrigger that will reach each guard, and one at the stern, over paddle wheel. The generator is directly coupled to the engine and is placed in engine room, the switch board being mounted on the tiller bulkhead.

Double-barreled steam capstans are placed two on the forward deck and one abaft the bunkers, and are operated by 7 by 8 inch horizontal double engines, which are placed below deck.

These boats are fitted with small refrigerating and ice-making plants that will produce about one-half ton of ice per day and cool a storage room in which all the perishable foods, both for the dredge and steamboats, will be kept.

SMALL STEAM TENDERS (PLATES 17 TO 20).

These boats are used for making surveys for proposed channels, taking soundings, laying buoys, and setting marks necessary for the placing and working of dredges. One, the *Vulcan*, was built last fall, and three others from the same lines are now under contract.

The hulls are of steel with wood decks, and are 80 feet long, 17 feet wide, and 3 feet 9 inches deep molded dimensions, with a draft of 24 inches when fully equipped. There are no hog chains, but the wheel beams are steadied by chains and braces. The frames are of 3 by 2 inch angle bars spaced 18 inches apart, and are strengthened by 2 by 2 inch reverse angles; there are three transverse bulkheads making four water tight compartments, and two longitudinal bulkheads made of three-sixteenths inch steel plate, with 2 by 2 inch angle bar stiffeners 24 inches apart. Stringer plates 18 inches wide and one-fourth inch thick run all fore and aft on each side, riveted to skin plating by gunwale bar of 2½ by 2½ inch angle, and to frames by gusset plates. At the bow these plates widen out to carry the outriggers and head block, and at engine room they extend inboard for the cylinder beams. The deck beams are of wood and are bolted to gusset plates and stringers. Two balanced rudders made of one-eighth inch steel plate, with 4-inch heavy tubing for stocks, work in tubular sockets which are secured to hull and braced to deck with gussets.

The cabin, besides housing the boiler and engine, is arranged to contain an office, which is fitted with four bunks, a kitchen, and mess room for crew. Four bunks are placed aft in engine room for crew's quarters. The pilot house is full forward on deck house, and access to it is by a ladder on forward deck.

The engines have cylinders 8½ inches diameter by 4 feet stroke, and are fitted with poppet valves and California cut-off. The pitman rods are of steel tube braced. The paddle wheel is 12 feet outside diameter by 12½ feet long, with 12 buckets 18 inches wide. The boiler is 44 inches diameter and 16 feet long, with 18 tubes 4 inches diameter, and is designed for a steam pressure of 180 pounds per square inch.

A small steam-power capstan is placed on forward deck, with 4 by 6 inch engines below deck.

Plate 4, accompanying, gives additional particulars relating to the hydraulic dredges under the secretary Mississippi River Commission.

Respectfully submitted.

THOMAS MIDDLETON,
Assistant Engineer.

Capt. H. E. WATERMAN,
Corps of Engineers, U. S. A.,
Secretary, Mississippi River Commission.

PLATE NO. 4.—*Principal features of United States dredge boats operating on the Mississippi River below Cairo, Ill.*

	Alpha.[a]	Beta.[b]	Gamma.[c]	Delta.	Epsilon.	Zeta.[d]
Hulls:						
Material	Wood	Steel	Steel	Steel	Steel	Steel.
Length	140 feet	214 feet	138 feet	175 feet	157 feet	157 feet.
Breadth	36 feet	58 feet	38 feet	38 feet	40 feet	40 feet.
Depth	8 feet	6 feet 11 inches	7 feet 10 inches	8 feet 4 inches	7 feet 6 inches	7 feet 6 inches.
Draft	59 inches	48 inches	54 inches	54 inches	46 inches	46 inches.
Displacement	640 tons	1,280 tons	640 tons	930 tons	665 tons	665 tons.
Main engines:						
Number	1	2	1	1	2	2.
Type	Vertical compound	Vertical triple expansion.	Horizontal cross compound.	Vertical compound	Horizontal tandem compound.	Horizontal tandem compound.
Diameter of cylinders	15, 27 inches	20½, 33, 38, 38 inches	18, 32½ inches	22, 48 inches	16, 26 inches	16, 26 inches.
Stroke	20 inches	24 inches	22 inches	24 inches	18 inches	18 inches.
Revolutions per minute	150	140	150	145	180	180.
Steam pressure	160 pounds	175 pounds	140 pounds	160 pounds	156 pounds	156 pounds.
Indicated horsepower	400	1,850	475	1,000	750	750.
Air pumps:						
Type	None	Duplex	Single	Single	None	None.
Cylinder		14 inches	10 inches	12 inches.		
Air pump		19 inches	18 inches	18 inches.		
Stroke		15 inches	18 inches	24 inches.		
Main pumps:						
Number	1	2	1	1	1	1.
Type	Single suction	Double suction	Double suction	Single suction	Double suction	Double suction.
Diameter of runner	66 inches	84 inches	69 inches	84 inches	69 inches	69 inches.
Peripheral velocity per minute	2,421 feet	3,080 feet	2,712 feet	3,080 feet	3,505 feet	3,505 feet.
Peripheral velocity per second	40 feet	51 feet	45 feet	51 feet	58 feet	58 feet.
Diameter of suction	30 inches	33¾ inches	24½ inches	34 inches	24 inches	24 inches.
Width of suction mouth	7 feet 6 inches	38 feet 8 inches	19 feet	33 feet 6 inches	20 feet	20 feet.
Maximum depth at which suction will work.	13 feet	20 feet	16 feet	16 feet	16 feet	16 feet.
Diameter of discharge	30 inches	33 inches	34 inches	34 inches	32 inches	32 inches.
Nominal capacity, sand per hour	500 cubic yards	1,600 cubic yards	800 cubic yards	800 cubic yards	1,000 cubic yards	1,000 cubic yards.
Average of tests, sand per hour	1,070 cubic yards		1,523 cubic yards	1,850 cubic yards	2,553 cubic yards	1,364 cubic yards.
Sand per hour per I. H. P	2.7 cubic yards		3.28 cubic yards	1.62 cubic yards	3.38 cubic yards	1.98 cubic yards.
Sand agitators:						
Type	Water jet	Water jet	Water jet	Mechanical	Water jet	Mechanical.
Type of pump	Helical	2 duplex plunger	Centrifugal	None	Centrifugal	None.
Size	15 inches	16 inches	18 inches		15 inches.	
Diameter and stroke of engine	8 and 10 by 12 inches.	8, 14½, and 24 by 15 inches.	12 and 22 by 14 inches	12¼ and 12¼ by 15 inches.	12 and 22 by 12 inches	12 and 12 by 16 inches.
Number of jets	6	18	9		10.	
Diameter of jets	2½ inches	1 inch	2½ inches		3 inches.	
Pressure	9 pounds	100 pounds	14 pounds		14 pounds.	

Electric light plant:						
Type of engine	Horizontal belt	Vertical direct	Horizontal belt	Vertical belt	Horizontal direct	Horizontal direct.
Diameter of cylinder	6 inches	7 inches	8 inches	7 inches	5 inches	5 inches.
Stroke	10 inches	7 inches	10 inches	9 inches	6 inches	6 inches.
Type of generator	4 pole	4 pole	4 pole	4 pole	4 pole	4 pole.
Capacity	9 K. W	15 K. W	12 K. W	9 K. W	12 K. W	12 K. W.
Search lights	1	2	1	1	1	1.
Arc lights	8		4	2	2	2.
Incandescent lights	70	125	75	100	75	75.
Boilers:						
Number	4	4	6	4	6	6.
Type	Mississippi River	Heine water tube	Mississippi River	Heine water tube	Mississippi River	Mississippi River.
Diameter	42 inches		48 inches		48 inches	48 inches.
Length	28 feet		28 feet		28 feet	28 feet.
Tubes	5	171	5	140	3 and 2	3 and 2.
Tubes, diameter	10 inches	3½ inches	11 inches	3½ inches	11 and 13 inches	11 and 13 inches.
Tubes, length	28 feet	16 feet	28 feet	16 feet	28 feet	28 feet.
Total heating surface	1,630 square feet	8,964 square feet	2,572 square feet	8,184 square feet	3,000 square feet	3,000 square feet.
Total grate surface	72 square feet	216 square feet	137½ square feet	213 square feet	143 square feet	143 square feet.
Ratio of heating surface to grate surface.	22.6	41	18.7	38.3	21	21.
Crews:						
On dredge	44	56	44	44	44	44.
On large tender	26	26	26	26	26	26.
On small tender	16	16	16	16	16	16.
On pile sinker	7	7	7	7	7	7.
General:						
Contractors	Hired labor	Lindon W. Bates	John S. George and Howard P. Eells, receivers Bucyrus S. S. and D. Co.	New York Dredging Co., Geo. W. Catt, president.	Springfield Boiler and Manufacturing Co., C. C. Brown, president.	Springfield Boiler and Manufacturing Co., C. C. Brown, president.
Contract price	Estimated, $90,000	$172,775	$85,530.60	$124,940	$102,000	$106,000.
When completed	July, 1895	January, 1896	August, 1897	August, 1897	March, 1898	March, 1898.

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[a] Originally built as an experimental dredge. Altered in 1895. Main pump changed in 1897.

[b] A bonus of $36,387.50 was allowed for extra output and $40,380.25 was deducted for noncompliance with terms of contract. This dredge was remodeled, as described, in 1898, and draft reduced to 48 inches.

[c] Proposal price, $84,880. Additional sum allowed for cabin, $1,029; deduction made for omission of stern spud, $378.40, making total contract price $85,530.60.

[d] The low efficiency and percentage of sand is attributed to the mechanical agitator. A water-jet agitator, similar to that on dredge Epsilon, will be installed.

APPENDIX 1 E.

REPORT OF ASSISTANT ENGINEER C. W. STURTEVANT ON DREDGING OPERATIONS ON THE MISSISSIPPI RIVER BETWEEN CAIRO, ILL., AND HEAD OF THE PASSES.

UNITED STATES DREDGING FLEET,
New Madrid, Mo., May 15, 1898.

CAPTAIN: I have the honor to submit my annual report upon the operations of the United States dredging fleet engaged in deepening the channels of the Mississippi River below Cairo, Ill., during the year ending May 15, 1898.

PROJECT.

The operations of the year comprise caring for the plant, repairing same, testing new dredges, and the field operations of deepening the channels of the Mississippi River by dredging, from Cairo downstream as far as the capacity of the available plant will admit. During the high-water stage when not engaged in field operations the plant is assembled for care and repair. The small force necessary to do this work is retained. At the beginning of the low-water season the plant is divided up into separate dredging parties, consisting of one dredge with pile sinker, steam tender, and such other plant as is necessary for its operation. Survey parties are also organized to make surveys of the shoal crossings to be dredged. The different plants and survey parties are all under the direction of the superintendent of dredging operations, who is provided with a suitable boat for making frequent trips over the field covered by operations, so that he may inspect the different parties and properly locate the work from personal examination and from maps made of the shoal channels.

PROGRESS OF THE WORK.

During the low-water season of 1895 the dredge *Alpha*, in charge of an assistant engineer, maintained a navigable channel between Cairo, Ill., and Cherokee Crossing, a distance of 90 miles below Cairo.

During the low-water season of 1896 two dredges were available, *Alpha* and *Beta*. Two independent parties were organized, each in charge of an assistant engineer. As the river did not fall to an extremely low stage they succeeded in keeping a navigable depth from Cairo, Ill., to Memphis, Tenn., a distance of 230 miles. No shoal water occurred below Memphis during that season.

CARE OF PLANT.

On May 16, 1897, the following plant, pertaining to dredging operations under your direction as secretary of the Mississippi River Commission, was moored at the bank at East Cairo, Ky., in the Ohio River, about 2 miles above its mouth: Three dredges, *Alpha*, *Beta*, and *Gamma;* 2 steamboats, *Minnetonka* and *Vidalia;* 2 pile sinkers, Nos. 21 and 33; 1 machine shop on barge No. 153; 1 quarter boat, No. 13; 1 measuring barge; 2 framed and planked flush-deck barges, Nos. 66 and 207; 2 small sunk-deck fuel flats; 1 small plunder flat; 1 calking flat.

During the month of June, 1897, barge No. 66 and the plunder flat were condemned, they being unfit for use and not worthy of repair.

On January 25, 1898, one of the fuel flats was sunk during a wind storm at Kentucky Point, opposite New Madrid, Mo., while testing the new dredge boats, *Epsilon* and *Zeta*.

Pile sinker No. 33, which was received from the third district in 1896, was floated out on the bank, at New Madrid fleet, during the high water in the month of April, to be used as a storehouse. The leads and machinery were removed; the hull was badly decayed and not worthy of repair.

During the month of July, 1897, the dredge *Delta* was received at St. Louis, Mo., from the New York Dredging Company, for testing before its final acceptance.

During the month of January, 1898, the dredges *Epsilon* and *Zeta* were received at Cairo, Ill., from the Springfield Boiler and Manufacturing Company, to be tested before final acceptance.

During the month of September, 1897, new pile sinker No. 971 was received from Cincinnati, where it had just been completed.

On April 7, 1898, the small steam tender *Vulcan* reported for duty at the New Madrid fleet, having been constructed by the Iowa Iron Works, Limited.

It was necessary during the season of field operations to charter the towboats *Future City*, *Jack Frost*, *H. H. Frisbie*, *Fred Hartweg*, and *Polar Wave*, only three of which, however, were employed at the same time.

The steamers *Mississippi* and *Search* were temporarily transferred to the dredge fleet during the dredging season.

On May 17, 1897, the steamer *Minnetonka* left East Cairo, Ky., to bring from Memphis, Tenn., and Greenville, Miss., certain plant transferred to this department. From the third district, four framed and planked flush-decked barges were received, as follows: Nos. 201, 205, 214, and 219. At Memphis, Tenn., there were received from the first and second districts four framed and planked flush-decked barges, Nos. 208, 211, 215, and 228; also pile sinker No. 61. At Luxora Landing, Arkansas, machinery for four pile sinkers was taken on board.

In July, 1897, the dredges *Alpha* and *Beta* were taken to St. Louis for repairs. The dredge *Gamma* was also taken to St. Louis to be tested. The measuring barge and pile sinkers Nos. 21 and 61 were taken to St. Louis to be used in testing the dredges *Gamma* and *Delta*. The above-mentioned plant was all returned to East Cairo, Ky., in the month of August, 1897.

In the latter part of November and the early part of December, at the close of the low-water dredging season, the dredges *Beta* and *Gamma*, with their accompanying plant, were laid up for the winter 1 mile above New Madrid, Mo.

The dredges *Alpha* and *Delta* were laid up about 1 mile above Caruthersville, Mo., until the latter part of February. When all danger from running ice was over, they were transferred to New Madrid, Mo., and tied up with the rest of the fleet.

On March 20 the steamer *Minnetonka* left New Madrid, Mo., for Keokuk, Iowa, with the dredge *Beta* and machine shop in tow, where the dredge is to be remodeled. The *Minnetonka* stopped at St. Louis, Mo., on its return, where repairs to the boat are now being made.

RELIEF TRIP TO SHAWNEETOWN, ILL.

On April 4, at 6.30 p. m., received telegraphic instructions to proceed to the above-named place with the steamer *Vidalia* and report to the authorities for any rescue work that might be necessary on account of the breaking of their levee on their river front. The *Vidalia* left at 10 p. m. the same date, with one small barge and four large skiffs. Stopped at Cairo, Ill., on April 5 and took on board fuel and four wagon loads of groceries contributed by the citizens of Cairo. When passing Elizabethtown, Ill., a stop was made in answer to a hail, and 300 loaves of bread and $50 in cash were added to the supplies on board. Arrived at Shawneetown at noon on April 6 and delivered supplies and cash to Mayor Carney and received receipts for same. The services of the boat and crew were offered to the Mayor. They, however, were not required, and the *Vidalia* left Shawneetown at 2.15 p. m. on the same day and arrived at New Madrid fleet on the 7th.

DREDGE FLEET HARBOR.

The present location of the dredging fleet, 1 mile above New Madrid, Mo. (70), is an excellent winter harbor, except during the medium high stage of the river in the winter season, when large quantities of drift lodge against the head of the fleet. There was no running ice in the river at this place last winter. In order to protect the fleet against ice and running drift, a breakwater was constructed at its head, composed of seven clumps of piles with their tops well braced to each other and stayed from on shore with cables. During the early part of the high-water stage the swift current scoured out the river bed around the foot of these piles, but as the tops were securely held the entire structure floated and prevented the accumulation of much drift under the fleet.

REPAIRS TO PLANT.

Dredge Alpha.—This dredge has a wooden hull with 12-inch gunwales, the sides of which were repaired with engraving pieces where necessary; all seams in the hull above the water line were calked and hull painted. The machinery received a general overhauling during the months of June and July, 1897. The floating pipes were also scraped and painted while ashore, having been allowed to go aground during the higher stage of the river. The jet pump was thoroughly repaired and the feed-pump plungers turned down.

The main Edwards pump was dismantled in June, preparatory to receiving a new one built by the Morris Machine Works. The new pump was received on board in the first half of September and set up and tested, after which the boat was ready for field service. It was quarantined, however, on September 19 by the Illinois State board of health, owing to suspected cases of yellow fever on board.

During the last five months one engineer and one helper have been engaged in grinding in check valves, blow-off valves, rebabbitting engine journals, turning down feed-pump plungers, and other minor repairs.

Dredge Beta.—During the first three months of this period the machinery of the dredge was thoroughly overhauled. The high-pressure cylinder on the after main pumping engine was bored out and new packing rings made for same. New bushings were placed in the chambers of the condensers. The six drum hoists and cutter machinery were almost entirely dismantled and reassembled. The floating pipes were scraped and painted while ashore, they having been allowed to go aground at a higher stage of the river. The baffle plates at the end of the floating pipe were repaired.

During the months of September, October, and November, 1897, this dredge was engaged in field operations, after which it was decided to remodel the dredge by widening it to decrease its draft and replacing the heavy suction ladder with cutter attachments by a lighter suction ladder with a jet agitator. Two new pump runners have been purchased and are ready for use when needed. The following parts were removed from the dredge and placed ashore as not being required in remodeling the boat: Six cutters, cutter gear and cutter engines, six drum hoists, all operating gear, push-spud cylinder, feed-pump suction tanks, spud hoist, one spud, one alum tank, cast-iron discharge elbows near main pump, stanchions supporting discharge pipe, and the two suction pontoon ladders.

The following parts were dismantled but kept on board: Two sheave chocks on bow of dredge, six copper telescopic elbows for suction pipe, wrought-iron discharge pipes between boilers, forward coal-bunker plates, filters and filter piping, water-closet pipes, and smokestacks.

The following repairs were made: The filters and filter pump were moved into the forward part of the engine room and coupled up, the forward battery of boilers was turned around and the breeching replaced, main steam pipes reassembled after turning forward the battery of boilers, an auxiliary steam line was established for siphons.

On March 20, 1898, this dredge left the fleet for Keokuk, Iowa, to be remodeled. The furnace walls and the asbestos wall linings on the forward battery of boilers were under construction at the time.

Dredge Gamma.—This boat was received from the contractors, who had just finished its construction, and tested in the early part of this year's work. When the dredging season was over the crew was discharged and only a few minor repairs were made, such as grinding in check valves, blow-off valves, and water gauges, and overhauling the feed pumps. The boiler-deck guard out forward has been widened around the spud to admit of a walk-way forward to the electric search light. In the month of April, 1898, the outside of the steel hull above the water line was scraped and painted.

Dredge Delta.—This boat was received from the contractors, who had just finished its construction during the month of July, 1897, and the tests were finished just before field work commenced. At the end of the season's work the entire crew was discharged, except an engineer and one helper, who were engaged in making minor repairs to blow-off valves, check valves, and renewing all the joints in the large steam pipes, which had been giving trouble during the working season.

During March and April the repair force was increased and general repairs to machinery commenced. Two feed pumps have been bored out and a new set of valves has been placed in the air pump. The brass bushing on the main pump shaft, as well as the one on the extra shaft, has been turned down, and the bearings are now being babbitted to fit same. The cutters have been entirely removed and the broken suction-ladder frame is now undergoing repairs. Coaming has been placed around the hatches in the boiler room to prevent the flow of water into the hull when cleaning boilers. The work of scraping and oiling the compartments in the hull is now under way.

Dredge Epsilon.—In the month of January, 1898, this dredge was received from the Springfield Boiler and Manufacturing Company, the contractors for its construction, to be tested. These tests were finished by the last of March, and a few minor repairs have been made by one engineer and helper since that time.

Dredge Zeta.—In the month of January, 1898, this dredge was received from the Springfield Boiler and Manufacturing Company, the contractors for its construction, to be tested. These tests were finished on the last of March, and a few minor repairs have since been made by an engineer and a helper.

Steamer Minnetonka.—This boat was built in 1883 and has a wooden hull. Previous to this season the boat had been sunk twice and had been overhauled at various times.

Previous to the dredging season the following repairs were made: Outside of cabin painted, cast-iron fire door wall liners renewed, and the fire front wall rebuilt under the boilers. On June 17, 1897, the cylinder head on the port side was broken and it was necessary to make a new one, as well as a piston head and a new set of packing rings for both engines.

The cylinder was also cracked for a distance of 12 inches. A new cap for the check valve of the doctor was made and put in place.

On September 21, while the steamer was being used as an inspection boat by the superintendent of dredging operations, it struck an obstruction and sank, having broken a hole in the bottom of the hull at the after end of the boilers about 20 feet long and 18 inches wide. The boat was raised on September 24 and taken to St. Louis to be repaired on the marine ways at that place, the water being so low that it was impossible to haul the boat out at Mound City, Ill.

During the working season the crack in the cylinder continued to increase until it was 25 inches in length. The cylinder was then banded by two 1-inch by 4-inch wrought-iron key bands.

This boat is now at St. Louis, Mo., receiving extensive repairs to machinery and woodwork. A new set of derricks has also been constructed.

Steamer Mississippi.—While engaged as a tender for the dredge *Alpha* this boat, which has a steel hull, struck an obstruction near Presidents Island, which broke a hole in the port side of the hull forward of the boilers and immediately below the water line about 8 by 10 inches. In December, 1897, a side dock was built and placed under this boat and the hole patched with boiler plate.

Vidalia.—This boat has a wooden hull and was built about fifteen years ago. It was not worth rebuilding and temporary repairs were under way during May, 1897, to fit it for another season's work as a survey boat.

The entire head and forward guard were renewed and the hull calked above the light water line. The skags, hog-chain braces, after transom, and rudder boxes were repaired as much as possible without docking. This boat, with some minor repairs, may be used for the same purpose another season.

Search.—In the month of July the wheel of this boat was rebuilt and a new set of packing rings turned up, preparatory to commencing the season's work with the dredge fleet. During March, 1898, the following repairs were made: New head block and new raised chock; twenty new outriggers, forward body; new facing, nosing, and top and bottom plank-sheer back to after end of boilers; replaced all cavils forward and decking under same; placed new decking around forward bitts and capstan; four new stationary stanchions; all the new decking was calked, as well as the top sides.

Two badly decayed places in the sides of the hull were found at the water line. The boat was listed to one side and new pieces put in place, held by screw bolts, as the top timbers were badly decayed. This boat should be docked and the hull thoroughly overhauled next year.

Steamer Vulcan.—This small steel-hull boat was received at the fleet on April 7, and a few changes to machinery and cabin, as well as additions, have been made to adapt it for use as a survey boat.

Pile sinker No. 21.—This sinker has only received minor repairs to chocks and leads, as required. The feed pump cylinder has been bored out.

Pile sinker No. 33.—This is an old pile sinker received from the third district in 1896, and only such minor repairs were made to hull as were necessary to keep it afloat. During the recent high water the machinery and leads were removed and the boat was allowed to go aground on the bank to be used as a storehouse, as it was not worth repairing.

Pile sinker No. 61.—The machinery, chocks, and leads on this boat have received such minor repairs as were incident to the service.

Pile sinker No. 971.—In the month of September the new pile sinker No. 971 was received, with hull and leads complete; the machinery and cabin were placed on board and the cabin constructed with hired labor.

New pile sinkers.—Pile sinkers Nos. 981, 982, 983, and 984 are now under construction by contractor at Cincinnati, Ohio. A force of men is now engaged at New Madrid fleet in preparing engines for these boats.

Quarter boat No. 13.—Repairs to this boat have not been necessary, except the calking of a few rake seams.

Measuring barge.—During November, 1897, this barge was taken to the Mound City ways, where it was docked and repaired. Valve bulkheads were braced and strengthened and strongly bolted together; a few of the bottom planks were removed and the hull cleaned out; all seams were calked and battened.

Barges Nos. 201, 208, 211, 214, 215, and 228 have had several timber heads put in place and plank-sheers repaired; the sides and rakes were calked just previous to the commencement of the dredging season.

Skiffs.—One carpenter has been engaged at odd times during April, 1898, in repairing skiffs for next season's work.

TESTING NEW DREDGES.

Gamma.—This boat was received from the Bucyrus Company April 28, 1897, and was taken to St. Louis, Mo., and preliminary tests commenced near Arsenal Island on June 11.

Official tests were commenced on June 16. During the first three days only clear water was pumped, after which the suction was lowered into the sand and actual dredging begun.

On June 19 the starboard crank-pin brasses became heated and gripped the crank pin so tightly that it was torn loose in the crank disk. The shaft, with runner attached, was removed for repairs, which were finished on June 25 and pumping resumed.

The bearings still continued to run hot when speeded above 100 revolutions per minute. Finally, by changing the valves so as to give more compression to the exhaust at the end of the stroke, carefully scraping all bearings, and substituting babbitted crank-pin bearings for brass, the revolutions were successfully increased to 150.

The efficiency tests were finished on August 11 and the capacity tests commenced. These tests were made by attaching the measuring barge to the end of the line of floating pipe 1,000 feet in length and pumping into it. By noting the time required to fill the barge and measuring the quantities of water and sand delivered the capacity was calculated. The capacity tests were finished on August 17 and the deflection tests on August 19, 1897.

There is transmitted herewith table of tests, giving details of results. (Plate 21.)

The time from June 16 to August 11, inclusive, while making efficiency tests, was spent as follows:

	Hours.
Operating	864½
Repairs	159
Not operating	344½
Total	1,368

Delta.—This boat was received from the New York Dredging Company, contractors for its construction, at St. Louis, Mo., on July 8, after the contractors had been making preliminary tests of their own since July 4, near Arsenal Island, opposite St. Louis, Mo.

The official efficiency tests were begun at noon on July 9 and continued until July 28, when the dredge was shut down to attach measuring barge for making capacity tests. Owing to the breaking of the gear wheel in the cutter machinery the first test was not attempted until July 29. This attempt proved a failure, owing to the difficulty in operating the valve in the barge. It was also found necessary to put a second floor on top of the false floor in the measuring barge to prevent a leakage of sand. While this was being done endurance tests were continued and capacity tests were not again commenced until August 2. The capacity tests were finished on August 10 and the deflection tests were made on the same day. There is transmitted herewith plate 22, giving details of tests and results.

The time spent in efficiency tests, from noon July 9 to 10.10 a. m. July 28, and from 5.45 p. m. July 30 to 10 a. m. August 2, is divided as follows:

	Hours.
Operating	$453\frac{3}{12}$
Repairs	$5\frac{1}{12}$
Not operating	66
Total	524⅓

Epsilon.—On January 4 the Government outfit had been placed on board and the final inspection was finished the following day. A few of the Government officers were placed in charge of the boat and some preliminary tests were made by the contractor at East Cairo, Ky., the crew, with the exception of the Government officers, being paid by the contractor.

The dredge was run about one and a half hours, and the only difficulty was that the high-pressure crank-pin brasses on the jet engine ran hot. On January 8 a double crew was placed on board and the dredge was moved from Cairo, Ill., to New Madrid, Mo., and anchored on the bar opposite by means of the spud at 12.30 p. m. on January 9.

Owing to a wind storm the work of driving piles was not commenced until the next morning. Pumping clear water was commenced at 12.15 p. m., but actual dredging was not begun until 7 p. m. January 10, owing to leaks from the discharge pipes into the air chambers of the pontoons.

Tests were continued with various delays, due to repairs, accumulation of drift, and changing piles in order to move the dredge farther in on the sand bar, as the river was rising rapidly.

At 4 p. m. on January 24 a crack was discovered in the hub of the starboard fly wheel of the main engine. Dredging was continued, however, stopping the pump each half hour for examination, but as the crack was found to be increasing in length the fly wheel was ordered removed. As the crack was found to extend 3 inches inside the bore of the hub it was deemed dangerous to continue running the engine, and the plant was shut down until the arrival of a new fly wheel.

On January 26 the dredge was moved into the chute above Kentucky Point and tied up to the bank to await repairs and a more favorable stage of the river.

On February 10 the tests were resumed, and on February 11 the engines were speeded up to 200 revolutions per minute. The pump and engine bearings indicated satisfactory performance, but the fly wheel caused such excessive vibration that this high speed was considered dangerous, and was reduced to 180 revolutions or less per minute. The work was continued until 6 p. m. February 12, when it was suspended to clean boilers, and on the next day orders were received to defer tests until the fly wheels should be replaced by new ones and these properly adjusted.

Smaller fly wheels were received on board March 5 and were erected by the contractor. On March 13 an endurance test was made, during which the main engines were run continuously and speeded up to 200 revolutions per minute, pumping water with a small percentage of sand through 500 feet of floating pipe, so as not to much exceed the development of 900 I. H. P. The test was successfully made, and on Plate 24, transmitted herewith, are two sets of indicator cards, showing the performance of the engines at time.

On March 14 a water test was made through 1,000 feet of floating pipe into the measuring barge, in order to test the working of the valve in the barge and to determine the velocity when pumping clear water. The velocity in the discharge pipe was found to be 14.1 feet per second; revolutions of the main pump about 180 per minute.

Capacity test No. 1 was made in the afternoon of the same day, but the material was found to contain such a large proportion of mud lumps that the dredge was moved 1,000 feet lower down on the bar to try to obtain average material. Test No. 2 was made on March 15, but the material was found to be about the same as that in test No. 1. The dredge was then moved about 7 miles up the river, opposite Island No. 10, where, after a second trial, a good location in average sand was found. Test No. 3 was made on March 16 and tests Nos. 4, 5, 6, and 7 were made on March 17. Plate 25, transmitted herewith, is a table showing the records and results. Plate 26 gives indicator cards taken at the time of each test.

On the 18th of March efficiency tests were again commenced and continued without any serious delay until 6 p. m. on March 28, when the dredge was accepted.

On Plate 29, transmitted herewith, is given the division of time by hours while engaged in making tests.

The column of "Sundays and holidays" includes certain authorized stoppages for which the contractor was not responsible.

Efficiency test, 35 days. Percentage of "Lost time" to "Available dredging time," considering only the first 30 days, equals 10.32.

Total cost of repairs during tests, including materials furnished, is $1,000.

Zeta.—This dredge having been outfitted, a final inspection was commenced on January 4, and finished on the 5th, at East Cairo, Ky. A preliminary test was made by the contractors. The dredge was run successfully for about two hours, pumping material through 500 feet of floating pipe. At the completion of the test, while raising the suction, "U" bolt on the crossbeam of the "A" frame, which holds the iron blocks for raising the suction, broke and allowed the forward end of the suction to drop to the bottom of the river. When the suction was finally raised the crossbeam of the "A" frame was found to be badly bent and had to be repaired and strengthened.

On January 8 a double crew was placed on board and the boat taken to the bar opposite New Madrid, Mo. (70), and anchored on the bar by means of the spud at 12.30 p. m. January 9.

Owing to a high wind storm the work of placing the plant was not begun until the following day. Dredging was commenced at noon on January 10, and the test was continued with various delays due to drift and the rapidly rising river, which necessitated frequent resetting of the piles in order to keep the dredge in shoal water.

On January 26 the test was temporarily stopped, owing to the extreme high stage of the river. The dredge was taken to the chute above Kentucky Point until such time as the stage of the river should admit of the continuation of the tests.

On February 10 the tests were resumed, commencing at 188 revolutions per minute and gradually increasing up to 200 revolutions per minute. After about an hour's run at this speed the starboard engine shaft was found to be cracked and the tests were again stopped until repairs could be made by the contractor. Plate 23, transmitted herewith, gives the records taken during the efficiency tests on this boat. Series No. 9 was taken two minutes before the engine shaft was broken. Plate 24, transmitted herewith, shows indicator cards of the *Zeta*.

Meanwhile the contractors had placed a new shaft and new and smaller fly wheels on the dredge, and on March 18 the five-hour efficiency test was made at 200 revolutions per minute, pumping through 500 feet of floating pipe. On Plate 24, transmitted herewith, are shown two sets of indicator cards taken during this test. On

March 21 the measuring barge was attached to the dredge and the capacity tests were commenced. Plate 27, transmitted herewith, shows the records and results of these tests. Plate 28 shows indicator cards taken at time of each test. The efficiency tests were resumed on March 24 and finished on March 28, when the dredge was accepted. Plate 29, transmitted herewith, shows the division of time by hours at different kinds of work.

The column of "Sundays and holidays" includes certain authorized stoppages for which the contractor was not responsible. Total duration of efficient tests, 30 days; percentage of "Lost time" to "Available dredging time" equals 14.82. Total cost of repairs during the test, including material furnished, is $1,455.90.

The dredges *Epsilon* and *Zeta* were built exactly alike in every particular except the agitator. On the *Epsilon* a series of jets at the end of the suction is used for stirring up the sand, while on the *Zeta* a vertical rake or harrow is used over the mouth of the suction and is given an upward and downward movement by a series of bell cranks driven by an engine on deck. In order to prevent a serious breakage of the machinery one of the small pins connecting one of the bell cranks is intended to shear in case the agitator strikes an obstruction. It was found while making the tests with the *Epsilon* that the best capacity test was made when pulling ahead at the rate of about 9 feet per minute. When the test of the *Zeta* was commenced it was found impossible to pull the dredge ahead at that rate, owing to the constant breaking of these shearing pins. It was therefore necessary to reduce the speed of advance down to less than two-thirds of that of the *Epsilon*, in order to have the shearing pins last long enough to make the barge test; in fact, two of these tests of the *Zeta* were made while one of the agitators was not in motion. Larger pins were used, increasing gradually in diameter up to 1⅜ inches; even these would break, and it was not thought advisable to increase the size of these pins, as it might break either the bell crank or some other part of the machinery, which was becoming badly racked in its service with the present sized pins. It was therefore decided to purchase a jet pump and place it on board in connection with this agitator for use in the field, as the capacity of the dredge was cut down nearly one-half, owing to the mechanical cutter.

DREDGING OPERATIONS.

Project.—The project under which the season's work was planned was to give temporary relief to navigation by dredging the shoal crossings of the Mississippi River from Cairo downstream as far as the available plant had capacity to perform the work. It was intended to extend the work as far as Graves Bayou, 250 miles below Cairo, Ill. The river between these points was divided into two subdistricts for the work of surveys. The party on the *Search* was to operate between Cairo, Ill., and the Missouri and Arkansas State line (128), the *Vidalia* to operate between the Missouri and Arkansas State line (128) and Graves Bayou (250). These survey parties were to carefully examine all crossings in their respective districts and make detailed surveys of such as were likely to require dredging. The dredging plant proper was to be divided into four separate parties, one dredge to each party and in charge of a master. There were required with each dredge one towboat, one pile sinker, and necessary barges, skiffs, and other outfit. The *Beta* required the services of the quarter boat for galley and sleeping purposes, as there was no cabin for such accommodations on board. All field operations pertaining to dredging and surveys were under the immediate supervision of a superintendent of dredging operations. He was to be provided with a suitable boat with which to make frequent trips to the dredges, survey parties, and such other places as pilots' reports, purchase of supplies, location of dredge work, and other exigencies of the service might require. The superintendent was to visit each crossing to be dredged and make personal examination, and that, in connection with a map of the locality made by the survey parties, to be taken as data in determining the actual location of the cuts to be dredged.

DESCRIPTION OF WORK BY DREDGES.

Dredge Alpha.—This boat was quarantined at East Cairo, Ky., by the Illinois State board of health, and the quarantine was continued by the Marine-Hospital Service until October 4, on account of suspected cases of yellow fever on board. On October 12 the boat left East Cairo for field operations. This boat dredged at four different bars during the season: Medleys (30), Phillips (81), Gold Dust (158), and Fleeces (243). The dredging at Fleeces Bar was finished on November 28, and this boat was then towed to winter quarters.

The U. S. S. *Mississippi* was used as a tender.

Plate 89 is a table which gives the conditions of the work and the division of time by hours. Total expenses of the *Alpha* during the low-water season of 1897 were $8,304.70.

On plate 90 is a table giving the cost and class of expenditures on each bar. The working of this boat with the new pump was satisfactory.

Dredge Beta.—On September 1 this boat was at East Cairo, Ky., and commenced making preparations for field work. It arrived at the first bar on September 4. The operations of this boat were confined to the vicinity of Point Pleasant, Mo., on two bars, known as upper Point Pleasant (79) and Phillips (81), as there was more work required at this place than at any other. The field work of the *Beta* was greatly delayed at times, owing to the excessive draft of the dredge, which would not allow it to pass over the crest of the bars. At one time during the work at Upper Point Pleasant Bar the dredge could not be dropped over the reef, and it was necessary to bring in the assistance of the *Gamma* to open the channel through the crest of the bar and allow the *Beta* to drop over the reef to commence work on the lower side. After the completion of the work at Point Pleasant the boat was tied up to the bank, as it could not pass over the next shoal place, known as Phillips Bar. It was expected, however, that this bar would soon wash out sufficiently to enable the boat to pass, but about this time the previous rapid erosion ceased, and in order for the boat to be used in opening this channel it was necessary to pull it head downstream through the bar without the use of the floating pipe, the idea being simply to pass the dredge below the bar and not in any way to increase the available depth, as the material was simply picked up in front of the dredge and deposited immediately behind it. The work at Phillips Bar was finished November 18 and the boat was moved to winter quarters. The chartered steamer *Future City* was used as a tender until October 8, when, owing to its great draft, it was deemed necessary to return it to its owners, and the *H. F. Frisbie* was transferred from the *Delta* to the *Beta*.

On Plate 89 is a table giving the conditions of the work and the division of time by hours on the two bars.

The total cost of field operations of the dredge *Beta* was $23,568.05. On Plate 90 is a table giving the cost and class of expenditures on each bar. The work of this boat was not satisfactory owing to the delays caused by excessive draft.

Dredge Gamma.—On September 1 this dredge began making preparations for field work, and arrived at the first bar on September 5. The following-named bars were dredged by the *Gamma:* Lazelles (82.5), Phillips (81), Upper Point Pleasant (79), Hathaways (104.25), Rocky Point (160), and Batsells (91). The work at Phillips Bar the second time was finished on December 2. All the other dredges had been moved into winter quarters. The *Gamma*, however, with a full crew, was tied up at the bank at Phillips Landing awaiting developments, the intention being, if any shoals should develop, to open them out with this boat, but on December 4 the entire plant was moved into winter quarters at New Madrid, Mo., as the constantly increasing stage of the river indicated that no further dredging would be required.

The chartered towboat *Jack Frost* was used as a tender until October 1, when the *Frost* was transferred to the *Delta* and the steamer *Polar Wave* was chartered for this purpose, but was found to be too small, and the steamer *Fred Hartweg* was chartered for the remainder of the season on October 11.

On Plate 89 is a table giving the conditions of the work and the division of time by hours on the different bars. The total cost of the field operations of the dredge *Gamma* was $18,951.27. On Plate 90 is a table giving the cost and class of expenditures on each bar. The only serious delay on this boat was due to repairs on account of the breaking of the cast-iron flanges by which the suction pipes of the pump are attached to the forward bulkhead. This was caused by the vibration of the hull, due to the high speed of the engine and pump. Temporary repairs could not be made, and it was necessary to await the casting of new flanges before operations could be continued. The work of this boat was very satisfactory.

Dredge Delta.—On the first of September this boat was placed in commission at Cairo, Ill., and arrived in the field for work on September 5. The following channels through bars were opened up by this boat: Island No. 34, upper reef (179), Island No. 40 (211), Presidents Island (235), Island No. 34, lower reef (179), Osceola Bar (164), Graves Bayou (250). The work at Graves Bayou was finished on November 18 and the dredge was moved to winter quarters. The chartered steamer *H. F. Frisbie* was used as a tender until October 1, when it was transferred to the *Beta*, and the *Jack Frost* transferred from the *Gamma* to this dredge. Many delays occurred in the operation of this boat, due not only to collision with passing boats, but also to the repeated breaking down of the cutter machinery. The number of hours spent in actual dredging by the dredge *Delta* was 472 and the number of hours in repairing was 574½.

Owing to the peculiar construction of this revolving cutter one single piece of drift 6 inches in diameter and 4 feet long would prevent the blades from revolving, as the drift would wedge in between the cutters and the supporting frame. It would then be necessary to shut down the pump, hoist the suction out of the water, and remove the drift.

On Plate 89 is a table giving the conditions of the work and the division of time by hours. The total cost of the field operations of the dredge *Delta* was $17,822.44.

On Plate 90 is a table giving the cost and class of expenditures on each bar. The work of the *Delta* was very satisfactory, taking into consideration the number of hours actually spent in dredging. Had there been on this boat a jet agitator instead of a mechanical agitator it would probably have done twice as much work as was actually accomplished. The cutters should be replaced by a jet agitator.

General.—Plate 89 is a combined table showing the conditions of work as performed by the four dredge boats, and showing the division of time by hours for the different boats. Examination of the same shows that the work of the *Gamma*, in comparison to her horsepower and capacity, is far ahead of any of the rest, principally for the following reasons: light draft and jet agitator. Had the *Beta* been of light draft, so as to admit her movement to any place desired, or had the *Delta* not lost more time in repairing its cutter than it spent in dredging, the *Gamma* would evidently have been placed third in the list.

INSPECTION.

The steamer *Minnetonka* was used as an inspection boat by the superintendent and to assist in placing the dredges in actual position on the bars, as well as towing of coal and delivery of supplies. The boat was employed continually from September 1 to January 1 in the work of inspection and towing of dredges to winter quarters, except during the period from September 21 to October 10, when the *Mississippi* was used as an inspection boat, the *Minnetonka* having been sunk at Gold Dust, Tenn., and after being raised sent to St. Louis, Mo., for repairs.

An inspection trip with Capt. H. E. Waterman, Corps of Engineers, United States Army, and secretary of the Mississippi River Commission, was made as far down the river as Montezuma Tow Head (312), about 5 miles below Helena, Ark. The *Delta* at that time was engaged in deepening the channel at Graves Bayou (250). The depth at Montezuma Tow Head, which had been the shoalest place below Graves Bayou at that time, was 9 feet, therefore no dredging was required below Graves Bayou. On November 28 the steamer *Minnetonka* met Capt. H. E. Waterman, Corps of Engineers, United States Army, at Natchez, Miss. (700), and proceeded to Fords Crossing (712), and an examination of all the bars was made from that point to Cairo, Ill. At Fords Crossing (712), Wilsons Point (531), Warfield Point (483), and Graves Bayou (250), there was found to be only 9¼ feet available steamboat water. All the other crossings had depths of 10¼ feet or greater. Natchez gauge at this time read 5 feet, Vicksburg gauge 0.5, and Memphis gauge 3.4; New Madrid gauge 6, and the Cairo gauge 7.2. These soundings show that there was not less than 9¼ feet from Cairo, Ill., to New Orleans at this time, and that only over four bars.

Capt. H. E. Waterman, Corps of Engineers, United States Army, also made frequent trips with the inspection party over the field covered by dredging.

The total cost of inspection from September 1 to December 31, both dates inclusive, was $10,554.65. On Plate 90 is a table showing the cost and class of expenditures.

SURVEYS.

The survey party on the steamer *Search* was engaged in making surveys in connection with dredging operations until the 1st of November, when it was transferred to the work of surveys, gauges, and observations. The territory covered by this party was from Cairo, Ill., to Missouri and Arkansas State line, a distance of 128 miles. The work of the party consisted in the examination and sounding of all crossings and making detailed surveys of such crossings as required dredging. The first surveys were made to cover the entire crossing and its approaches, together with the low-water shore lines, ranges on which soundings were made being located about 100 feet apart in the immediate vicinity of where the work was to be done. Surveys were always made immediately before and after the work of the dredges, and at various intermediate periods when possible. Tracings of these surveys were made and blue print copies furnished the master in charge of the dredge at work on that bar and the superintendent of dredging operations, as well as a copy to your office. After the withdrawal of this party from dredging operations the surveys in this district were continued by the addition of extra recorders to the dredges *Beta* and *Gamma*, there being originally a recorder on each dredge boat to locate the position of the dredged cuts on the map and compile data for the daily reports. The expenses of the steamer *Search* were $3,887.29. On Plate 90 is a table giving the class of expenditures on this work.

Vidalia.—The duties of the party on this boat were similar to those on the steamer *Search*. The territory covered was from the Missouri and Arkansas State line (128) to Graves Bayou (250), a distance of 122 miles.

At the completion of the season's work the steamer *Vidalia*, commencing at Graves Bayou (250), made a survey of all dredged bars.

The expenses of the steamer *Vidalia* while engaged in this work were $4,786.81. On Plate 90 is a table showing the class of these expenditures.

The plates referred to in this report, 30 to 88, inclusive, are from the maps transmitted to your office from these parties.

The total expenditures of the dredging operations for the season are as follows:

Preparation and moving into field of all plant		$3,269.44
Medleys Bar	$2,029.74	
Point Pleasant Bar	7,490.78	
Phillips Bar	26,821.76	
Lazelles Bar	2,310.84	
Batsells Bar	728.20	
Hathaways Bar	2,299.51	
Gold Dust Bar	1,507.41	
Rocky Point Bar	1,523.99	
Osceola Bar	1,989.33	
Island No. 34 (upper reef)	988.88	
Island No. 34 (lower reef)	1,947.20	
Island No. 40 Bar	3,687.06	
Presidents Island Bar	3,771.32	
Fleeces Bar	1,468.14	
Graves Bayou Bar	2,175.83	
		60,739.99
Towing to winter quarters of all plant		4,637.03
Inspection, steamer *Minnetonka*		10,554.65
Surveys, *Search*	3,887.29	
Surveys, *Vidalia*	4,786.81	
		8,674.10
Total cost dredge operations		87,875.21
Number of bars dredged, 15; average cost per bar		5,858.35

DESCRIPTION OF WORK BY BARS.

Medleys.—This shoal is 30 miles below Cairo, Ill. The dredge *Alpha* arrived at this bar on October 12, and commenced dredging the next day. The work was finished on October 22. The time, however, charged to the operations on a bar extends from the time of the arrival of the plant at that bar until its arrival at the next one. The number of hours chargeable to this bar is 288, of which 51 were lost in repairs, most of it being spent in tightening up the pump runner, which had become loose on the shaft. The number of hours spent in actual dredging was 168¼.

Before dredging, the datum depth over the bar was 9.1 feet, as shown by Plate 31. By examination of Plate 32, made from survey of October 21, one day after the completion of the work, it will be seen that the datum depth had been increased to 10.5 feet. It will also be noted that the point of the upper reef had been removed. This datum depth was retained during the season and no further work was required. The dredged cuts were properly located. The material dredged was medium fine sand.

The total expenditures on this bar amounted to $2,029.74.

Channels in the vicinity of Point Pleasant, Mo.—From a point about 1 mile above Point Pleasant, Mo., and 79 miles below Cairo, Ill., over what is known as Upper Point Pleasant Crossing, and extending down through Sam Phillips and Lazelles crossings for a distance of about 3¼ miles, were the most troublesome bars which impeded navigation below Cairo on the Mississippi River.

Plate 33 is a general map of the vicinity, showing the different bars, crossings, and side channels. At the time of the commencement of the work there were seven routes available for improvement, all of which were used by the various steamers as the river continued to fall. A steamer in coming downstream above the limits of this map would cross over from Nolans Light to Toneys Tow-Head on an available depth of 12 feet with good alignment; thence on down the deep pool along the tow-head, entering the limits of this map just above the letter B. Upon the arrival at the point B, there were two possible channels, marked on the map as B-K and B-C. The available depth down the route B-K along the shore by Point Pleasant was a little over 5 feet, and the channel was rapidly deteriorating, owing to the encroachment of the bar in toward the shore in the immediate vicinity of the town.

The natural draft of the water after leaving the pool A-B is not down the route B-K, owing to the deflection of the body of water by a false point on the right bank above B. The route B-C was mostly used by steamboats, and received a greater portion of the discharge from the pool A-B on account of the more natural alignment of the channel with the direction of the axis of the upper pool.

An examination of the original large-scale maps shows that all the contours at the lower end of the pool B point toward C rather than toward K. The length of the channel that required dredging at the line B–C was about one-quarter that required on the line B–K, with a deep pool below the reef into which the spoil could be deposited, while in the channel B–K there was no deep water available for this purpose. Therefore the route B–C was chosen for improvement, and will be known in this report as Upper Point Pleasant Crossing.

Upon arrival at the middle of the pool C–D, there were again two possible channels, one continuing on down by the pool by D, and the other turning to the right on the line C–L–K and uniting with the channel coming down by Point Pleasant, and thence down the shore to F. The channel C–D was best adapted for improvement, owing to its direct alignment with the current at C and its much greater depth. The depth over the shoal at L–K was about 5 feet, and was growing less on account of the movement downstream of the upper reef. Upon arriving at the lower end of the pool immediately below D, there were two more possible channels, D–E and D–M. The former was considered the better, owing to its alignment with the pool above and its greater depth. There was an available depth of 7½ feet down to E and only 5 feet in the channel down to M. The current at E was much swifter than at M, and the channel D–M was much more likely to be filled up by the movement downstream of the bar above and the settlings out of the cut made by the last flood immediately below the Government light near D. When the point E was reached, there were again two more possible channels, both of which had been used by steamboats, E–F–G–H and E–N–O–P–Q. On the latter route there were three shoals—one between E and N and one between O and P, and the other immediately below Q. The channel E–M was used by steamers about three weeks previous to the commencement of operations on this bar, but was finally abandoned owing to the encroachment of the upper reef down on the head of the bar on which the Government light is shown on this map, at the lower end of the channel E–F. The channel E–F had only been used by steamers about a week before the commencement of the work on these bars.

During last season the bar through which this channel E–F passes had become one continuous sand bar, but during the last high water the current had washed out a channel through the crest of the bar, but it was not of sufficient depth to admit of navigation. Just before the commencement of improvement at this point, the channel E–N having been closed by the encroachment of the upper reef down to the Government light, the volume of water was thrown through the channel E–F, which commenced to scour out rapidly and was immediately used by the steamboats. The current through this channel was very swift. Every indication being favorable for the continued natural improvement of this channel, it was chosen in preference to either D–M or E–M. It was thought that by improvement of the channel known as Upper Point Pleasant Crossing the increased volume of water would be directed down along the line C–D–E–F, and that possibly this channel, which is known as Sam Phillips Crossing, would not require the use of the dredge to open it up.

Following down the channel to the lower end of the pool F–G, it was again divided into two possible routes—one, G–H, known as Lazelles Crossing, and the other one along down the shore by Lazelles Landing. The depth over the crossing was 7½ feet and carried nearly the entire volume of water, while the channel along the shore was narrow and tortuous, with an available depth of only 5 feet. The route through this series of bars chosen for improvement was as follows: B–C–D–E–F–G–H, which involved the removal of shoals by dredging at B–C, D–F, and G–H.

Upper Point Pleasant Bar.—The dredges *Beta* and *Gamma* were both employed at different times on this bar. The *Beta* commenced work on September 4 and continued until September 14. Serious delay was occasioned on account of the draft of the *Beta*, which was about 7 feet, and prevented her from being dropped over the crest of the bar. It was finally necessary to bring in the assistance of the dredge *Gamma* and open a narrow cut across the crest of the reef to allow the *Beta* to drop over the bar and attack the reef from the lower side.

At the completion of the work on the bar the *Beta* had been running continuously for one hundred and twenty-seven hours, excepting a delay of one hour, which was spent in tightening up the bolts which held the cast-iron nozzles on the lower end of the suction elbows.

The material dredged was medium fine sand.

On Plate 34 it will be seen that the datum depth for the bar along the line of the proposed channel was 1.8. Plate 35, made immediately after dredging, shows this depth increased to 7 feet, which gives the increased depth of the channel or lowering of the crest of the bar as 5.2 feet.

The *Beta* was then tied up to the bank, owing to the impossibility of floating the dredge over the bar known as Phillips Crossing; thus the time from September 14 to September 29, while tied up to the bank, has been charged to Upper Point Pleasant Bar, and accounts for the three hundred and fifty-five hours, "Sundays and holidays."

The depth over Upper Point Pleasant Bar was retained until about October 7, when, owing to the continued falling of the river and the constant movement of sand over the reef, the datum depth had been retained, but not the available steamboat depth. See Plate 36. On October 14 the dredge *Gamma* commenced work at this place and completed same October 18 without delay, the datum depth having been increased to 9 feet. This depth was retained during the remainder of the season and no further work was necessary. The cost of the work on this bar is as follows:

Dredge *Beta*	$6,371.08
Dredge *Gamma*	1,119.70
Total cost	7,490.78

The location of the dredged cuts at this bar was correct.

Phillips Bar.—This bar is situated 81 miles below Cairo, Ill. The dredges *Alpha*, *Beta*, and *Gamma* were employed in the opening up of the channel over this bar. On September 13 the actual available steamboat depth was only 6 feet, and it was impossible to drop the dredge *Beta* over this bar working backward downstream and discharging through 1,000 feet of floating pipe as had been customary. Only two plans seemed admissible—one to take the *Gamma* away from her work below and have her make the opening for the *Beta*, and the other to try forcing the *Beta* over the shoal, working head downstream and simply picking up the material in front and depositing it behind, as it was impracticable to use the floating pipe, working in this manner in the swift current at this place. The latter method was not attempted at first, owing to the danger of grounding the *Beta* and the possibility of breaking in two of the hull. On September 16 the dredge *Gamma* was moved to this bar and commenced dredging with only 50 feet of discharge pipe; it being the intention to dredge off the tops of the mud lumps which were found at the lower end of the bar and were of such tenacity that the natural velocity of the current had no effect whatever toward their erosion. Previous to this time these lumps of mud, which had stopped the natural erosion of the channel, were not known to exist.

On September 21 the flanges connecting the suction pipe to the forward bulkhead broke, and it became necessary to tie the *Gamma* up to the bank until new flanges could be cast and put in place on board. Various temporary expedients were proposed, but proved impracticable, as the breaks were in the suction pipe and necessarily had to be perfectly air-tight and withstand the vibrations of the machinery, which is rather excessive on this boat.

It was then decided to adopt the second method of procedure, and on September 29 the dredge *Beta* was taken to the upper end of Phillips Crossing and anchored by means of the spuds, head downstream, in water 7½ feet in depth. The boat was then pulled downstream into the bar by means of the head cables, with the cutters lowered and pumps working, picking up the material in front of the boat and depositing it at the stern, the object being to get the dredge below the bar and not necessarily give any permanent improvement to the channel. Work continued night and day under my immediate direction until the morning of October 2, when the lower edge of the reef was passed. The length of this cut made in passing the dredge over the bar was 2,510 feet. The boat was aground on the sand on either one side or the other almost the entire length of the cut, and as the boat was pulled downstream by the cables the side that was aground naturally raised up over the sand as it advanced. Many times during this cut one guard of the boat would be from 12 to 18 inches out of water and the other guard would be submerged from 2 to 6 inches under water, which, had it not been for the 17 inch water-tight bulkhead constructed across all doors and windows, would have admitted the water of the river into the hull. The last 600 feet of the cut was made through these stiff mud or clay lumps, and it was necessary to run the cutter engine at full speed in order to cut them up. After the passage of the *Beta* over the bar it was found that the cutter machinery had been badly damaged by this excessive work, and it was necessary to shut down from October 2 to October 4 for repairs, after which dredging by the *Beta* was commenced in the mud lumps at the lower end of the bar.

On October 14 it was found that the cutter machinery and the brackets of the suction pipe at the bow of the hull required considerable repairs, and the plant was tied up to the bank while doing this work. The repairs were completed on October 18 and dredging resumed.

A part of this work consisted of discharging the dredged material into what is known as Lower Point Pleasant Channel, with a view of its partial closure, so as to diminish the flow of water through that channel and deflect it into the channel being opened up by the dredge.

While working on the left side of the channel the material was deposited in what is known as Darnells Point-Way for the same reasons, it being evident that a large percentage of the water passing down the river at this point was passing through other channels than the one being dredged, and the volume naturally flowing through this was not sufficient to make a navigable channel.

The results of the fills made in Darnells Point-Way were beneficial and increased the velocity of the water through the dredged channel. It would seem advisable in future operations to attempt the partial closure of secondary or side channels either by deposit of the spoil in these channels when possible, or the special location of a dredge at their upper ends with the idea of forming a partial dam across them, or else experiment in their partial closure by some temporary obstruction, such as piles and movable dams.

On October 2 repairs to the broken flanges to the dredge *Gamma* had been made and the work resumed by it at Phillips Crossing on the lower end of the bar, the *Beta* having worked up through to the upper end. Dredging by the *Gamma* was continued without serious delay until October 14, when the work assigned to this dredge was completed.

On October 23 the dredge *Alpha* was transferred to Phillips Bar, and commenced dredging just below the *Beta* to assist in clearing out the lumps of sand which had formed and over which the *Beta* could not pass, owing to the great draft of the boat. Dredging by the *Alpha* was continued without serious delay until October 29, when the work for which this dredge was placed on the bar was finished.

The *Gamma* again commenced dredging at the lower end of this channel on November 13, as this was the only bar with less than 9 feet over its crest. Work was continued without interruption until 6 p. m., November 17, when, on account of a slight rise in the river, no further dredging was necessary, and the *Gamma* was tied up to the bank to await developments in the stage of the river, and the dredge *Beta* was moved to winter quarters at New Madrid, Mo.

On November 24 a survey of Phillips Bar was made, from which it was seen that the partial dam constructed across the head of the channel, known as Darnells Point-Way, had been scoured out near its center to a depth of about 7½ feet. On November 26 the dredge was taken to the upper end of Phillips Crossing and placed in such a position that the end of the floating pipe would discharge into this gap. This work was discontinued on December 2, owing to the increased stage of the river, which rendered further work unnecessary, and the dredge was moved to winter quarters at New Madrid, Mo. The total length of the channel as dredged through this bar by the dredges *Alpha*, *Beta*, and *Gamma* was 5,920 feet. It is still thought that the location of the dredging in this vicinity was proper, but that the work of obstructing the flow of water through side channels should have been commenced at the same time as the dredging out of the channel itself. The material dredged on this bar was medium fine sand, except at the lower end, where the clay or mud lumps were encountered.

The cost of operations in the opening up of the channel through Phillips Bar is as follows:

Alpha	$1,150.73
Beta	16,091.72
Gamma (first time)	5,337.73
Gamma (second time)	4,241.58
Total	26,821.76

Lazelles Crossing.—This bar is 82.5 miles below Cairo, Ill. The dredge *Gamma* arrived at this bar on September 4 and continued dredging without delay, except when removed to Upper Point Pleasant Bar to open a cut for the passage of the *Beta* over the reef. The work was finished at Lazelles Crossing on September 15.

Examination of Plates 50 and 51, made just before and after dredging, shows that the crest of the bar was lowered 7.8 feet. A good steamboat channel was retained here during the remainder of the season. The material dredged was medium coarse sand. The location of the dredged cuts is considered to be correct. The cost of dredging on this bar was $2,310.84.

Batsells.—This bar is 91 miles below Cairo. Heretofore, during the low stages of the river, Cherokee Crossing, which is 1 mile above Batsells, has always given considerable trouble to navigation. During this last low-water season, however, Cherokee Crossing retained a good navigable depth over the bar simply from natural erosion, the crossing having moved downstream, leaving the upper pool at its extreme lower end and funneling almost the entire discharge of the river through the channel. Heretofore the channels left the upper pool at two points, one near its lower end, which was long and tortuous, and the other, which had been dredged in previous seasons, passing out of the upper pool nearly 2 miles further upstream, where it could not get the full force of the current.

This unusual erosion of Cherokee bar caused a deposit in the locality 1 mile lower down, near what is known as Batsells Landing, where it had heretofore been deep.

As this shoal at Batsells did not occur until after the erosion of Cherokee bar, it was not noted in the early part of the season as likely to require dredging.

The dredge *Gamma* commenced work on this bar on November 8 and continued without delays of any kind until the completion of the work, on November 10. Only 500 feet of discharge pipe was used on this bar, owing to the swift current and the short distance over the crest of the reef, enabling the capacity of the dredge to be considerably increased.

The material dredged was medium coarse sand.

By examination of Plates 55 and 56 it will be seen that the crest of the bar was lowered 5 feet. About December 19 (see Plate 57) the channel had moved downstream, but retained its same datum depth.

It might be supposed from this natural downward movement of the channel that the original cuts should have been located lower down. It will be seen, however, by examination of Plate 55 that the work of the dredge in opening up a channel lower down on the bar would have been doubled. This would seem to indicate that sometimes some of the best work done by dredging may finally be filled up and the channel moved lower down. This movement of the channel is the natural result of opening of the reef and causing an increased flow of water in this direction, which after awhile scours out the lower side of the dredged channel and allows the reef on the upper side to encroach down upon the dredged cuts until they may, finally, be filled up, the channel remaining good, however, during the entire operation.

The cost of the work by the dredge *Gamma* on this bar was only $728.20.

Hathaways Lower Crossing.—This bar is 104.25 miles below Cairo. In this vicinity there were two channels open to improvement, both of which were used by steamers before commencement of the dredge work. This is a case in which the upper pool along the left hand shore laps down by the lower pool along the right-hand shore, the channel known as Upper Hathaways Crossing, leaving the upper pool about 2 miles from its lower end and entering the lower pool at its extreme upper end. Hathaways Lower Crossing leaves the upper pool at its extreme lower end and enters the lower pool about 2 miles from its upper end. Could the water have been confined and not allowed to pass through the upper crossing, the lower crossing would evidently have washed out as the river fell and no dredge work would have been necessary, as the channel over the reef at the lower crossing was in direct alignment with the upper pool. This channel was chosen for improvement, and on October 19 the dredge *Gamma* commenced dredging and continued without serious delay until October 30, when the work at this place was finished.

By examination of Plates 59 and 60 it will be seen that the datum depth was increased from 7.5 to 10 feet, or an improvement of 2.5 feet. This depth was retained even as late as thirty-one days after dredging, as is shown by Plate 61. The cuts on this bar seem to have been properly located. The material dredged was coarse sand. Had there been more dredges to handle the work in hand, two days' work of the *Gamma* would have been well expended in filling up the channel known as Upper Hathaways, so as to increase the volume of water through the dredged channel.

Gold Dust Crossing.—This bar is 158 miles below Cairo. The dredge *Alpha* arrived at this place on November 1 and commenced dredging the next day and continued without delay until November 6, when the work was finished.

The material dredged was medium coarse sand.

By examination of Plates 62 and 63, made before and after dredging, it will be seen that the crest of the bar was lowered 1.5 feet for a width of over 200 feet. This channel continued to improve after dredging was discontinued. On November 27 the crest of the bar had been lowered by natural erosion an additional 2 feet, and the channel had meantime moved lower down. The location of the cuts in this case might just as well have been 300 or 400 feet lower down the river, but at the time of the location of the dredge a survey had only been made as far down as the Government light, and the exact conditions were not known. Owing to the rapid caving going on at the time immediately below the light, and from the path of surface floats run at that time, it was thought that this was the most desirable place to do the work. The dredging was done along the line of the deepest water, as determined by examination and not by survey. Thus is shown the important part which a survey takes in the proper location of dredging channels of the Mississippi River below Cairo. The total cost of the work of the dredge *Alpha* at this bar was $1,507.41.

Rocky Point.—This bar is 160 miles below Cairo and about 1 mile above Elmot Landing, Arkansas. The location of this shoal is rather peculiar, as it occurs in the middle of a deep revetted bend, known in the improvement works as Fletchers Bend; in fact, nearly all the material removed at this bar was immediately over a mattress 250 feet in width. This bar was formed from the encroachment of the Elmot sand bar in toward the revetted bend. The width of the bar had become so great that during the high stage of the river a channel had been washed out across the bar near Elmot Island, and probably two-thirds of the discharge of the river crossed the crest of this bar through this auxiliary channel, but it was spread out over a width of 4,000 feet, and in no place sufficiently defined to admit of improvement. The water through this secondary channel robbed the main steamboat channel, and there was not sufficient velocity along the revetment to scour out the sand as the river fell, and thus the obstruction to navigation was formed.

The dredge *Gamma* commenced operations at this bar on October 31, and continued without serious delay until November 5, at which time the channel was 200 feet in width and had a depth of 9¼ feet. The material dredged was medium fine sand. It was necessary while working at this bar to move the *Gamma* out of the channel for steamers to pass. A side line was kept stretched across the channel and made fast to the bank to pull the dredge back into position after the passage of the boat. The line was weighted with cast iron so that it would lie on the bottom of the river when slacked for boats to pass over.

By examination of Plates 65 and 66 it will be seen that the datum depth was increased 3 feet, and twenty-two days after the completion of the work Plate 67 shows still another foot increase of depth. The cost of the work of the dredge *Gamma* at this place was $1,523.99. The cuts of this bar were properly located.

Osceola Bar.—This bar is 164 miles below Cairo, and is also known as Plum Point Crossing. The work on this bar by the dredge *Delta* was commenced October 28 and continued to November 3, at which time there was 9¼ feet in the channel for a width of 175 feet. Work at this bar was delayed several times by the cutter machinery becoming entangled in drift and breaking its sprocket chain and other parts, which had to be repaired. The material dredged was coarse sand.

Quite a number of the crew engaged on the boat deserted, owing to the proximity of yellow fever on shore. All of the laborers and firemen left the *Jack Frost,* which was tender to the dredge. Men were brought from St. Louis to complete the crews. Examination of Plates 68 and 69 shows that the crest of the bar was lowered 4 feet by the work of the dredge. The depth was retained, as shown by Plate 70, except for the small lump near the middle of the dredged channel, which shoaled 1 foot twenty-three days after dredging. The cuts on this bar were properly located. The cost of deepening this channel by the dredge *Delta* was $1,989.33.

Island No. 34 (upper reef).—This bar is 178 miles below Cairo and 1 mile above what is known as Island No. 34 (lower reef). In the early part of the season this shoal did not develop, while the improvement of the lower shoal was necessary in the early part of September. No work was required at the upper reef until October 23, at which time the *Delta* commenced dredging the channel at this place. Work continued without serious delay until October 27, when it was finished.

The material dredged was coarse sand.

Plate 71 shows the relative position of the upper and lower reefs. By examination of Plates 72 and 73, before and after dredging, it will be seen that the datum depth was increased 2 feet, which was retained throughout the season, as indicated by Plate 74, made from survey of November 24, twenty-eight days after dredging.

The dredged cuts were located on the upper side of the channel, although it would seem from Plates 73 and 74 that it might have been better to have it worked on the lower side of the channel. The distance, however, to be dredged in order to open out this side of the channel would have been double that required on the upper side.

The cost of the work of the dredge *Delta* at this place was $988.88.

Island No. 34 (lower reef).—This bar is 179 miles below Cairo. The dredge *Delta* commenced work at this place on September 9 and continued with various delays, caused by the breaking of the head cables and the cutter machinery when snags were encountered.

The material dredged was coarse sand.

The work was finished on September 17. By examination of Plates 75 and 76 it will be seen that the crest of the bar was lowered 5 feet. This depth was retained throughout the season and continued to increase in width, as is shown by Plate 77, made from survey of November 24, sixty-nine days after dredging. The lower end of the cuts at this bar were not located in the line of the deepest water, but on a line nearer parallel to the direction of the flow of the current. This caused a very deep cut to be made at the lower edge of the reef, and when the dredge commenced work only 500 feet of pipe were attached, enabling the capacity of the dredge to be greatly increased while dredging out this portion of the channel.

The cuts seem to have been properly located.

The total cost of the work of the dredge *Delta* at this bar was $1,947.20.

Island No. 40.—This bar is 211 miles below Cairo and 19 miles above Memphis, Tenn. The river here is divided into two channels by Island No. 40. The main channel of the river has been partially filled up with sand, and is shoal but very wide. The current is slack and there is no defined channel here, while through the chute, where dredging was done, the channel is narrow and generally deep. In crossing near the head of the chute, where the channel leaves the head of the island and crosses over to the left bank, there is a shoal, and the channel passing over this is divided into two parts by the wreck of the Anchor Line steamer *City of Hickman*. The channel chosen for improvement was on the upper side of the wreck, on account of the better alignment from the pool above and the less distance to be dredged. The dredge *Delta* commenced work at this bar on September 18 and continued until September 30, when a good channel had been opened. Numerous delays were met with from logs and snags becoming entangled in the cutter machinery and breaking it. The low-pressure piston rod in the main engine was found to be bent, and it was necessary to replace it with another one, which was on board. By examination of Plates 78 and 79 it will be seen that the datum depth was increased at least 3 feet, and the channel was much straighter and wider than before. This depth was retained throughout the season. On Plate 80, made from survey of November 22, fifty-three days after dredging, it will be seen that another channel had opened up on the lower side of the wreck, each channel being 1 foot deeper than the dredged channel at the time of completion of the work. At the end of the season the main channel on the lower side of the wreck was the widest.

The material dredged was coarse sand and fine gravel, with occasional mud lumps. There can be no question but that relief to navigation was given quicker and at less cost by improving the upper route. The cost of the operations of the dredge *Delta* at this bar was $3,687.06.

Presidents Island.—This bar is 235 miles below Cairo, Ill., and 5 miles below Memphis, Tenn. The dredge *Delta* commenced work on this bar on October 5, and continued, with many serious delays, until October 19. The current at this place was very swift, but there was apparently very little erosion of the bar, as it is formed of gravel and large pieces of lignite. One block of lignite brought out by the cutters measured 8 feet in length, 4 feet in width, and 3½ feet in thickness. These blocks were continually carried up on top of the suction ladder by the cutters, often stopping and breaking them. It was necessary every few hours to raise the suction out of the water and remove these obstructions. The bushings on the cutter shaft also wore out rapidly from the severe work of the cutters. On October 11 it was necessary to stop for repairs for five days. The time spent in actual dredging at this bar was 107½ hours, while the time spent in repairs was 150½, or about 38 per cent of the total time charged to this bar; 15½ hours were lost in moving out of the channel for passing boats and being in collision with same. Examination of Plates 81 and 82 shows that the channel was deepened 2½ feet. Plate 83, made from survey of November 8, shows that the depth had increased an additional foot and one half; meanwhile another channel had opened across the bar lower down and close onto the wreck of the *Golden City*. This channel, although showing a depth equal to that of the dredged channel and somewhat wider, was not preferred by the boats for navigation, owing to its crooked alignment and close proximity to a dangerous wreck. Plate 84, made on December 17, shows the depth in the dredged channel had been retained and increased in width, but the channel down by the wreck had also increased slightly in depth and was much wider, owing to the removal of the wreck with dynamite by the snag boat *H. G. Wright*.

The total cost of the work of the dredge *Delta* at this bar was $3,771.32.

Fleeces Crossing.—This bar is 243 miles below Cairo and 13 miles below Memphis, Tenn. The dredge *Alpha* arrived at this bar on November 9 and began dredging on November 11, after completion of the survey. The work at this bar was delayed by the bursting of the starboard-bellows joint of the jet-pump delivery and of the rubber floating-pipe connection at the stern of the dredge. The wearing down of the main pump bearing also occasioned temporary delay. These repairs consumed 16 of the 224 hours chargeable to the bar. Examination of Plates 85 and 86, made before and after dredging, shows that the channel had increased in depth by 2 feet. The cuts at this place were properly located. The material dredged was medium coarse sand.

Total cost of the work of the dredge *Alpha* at this bar was $1,468.14.

Graves Bayou.—This bar is 250 miles below Cairo and 20 miles below Memphis, Tenn. The dredge *Delta* commenced work on November 7. Here again the cutter machinery caused serious delays. The bushings of the cutter shaft wore out, the coupling on center of the cutter shaft pulled off, and the I beams supporting the journal bearings of the cutter shaft were found to be cracked, and finally all of the remaining sprocket chain was lost overboard on November 17 and could not be found. By this time there was a good channel 10 feet in depth and 175 feet in width, and it was decided to suspend the work and move the boat to winter quarters, as indications were favorable for a rising stage of the river. The cuts here were not made on either the shortest or the deepest line, but made parallel to the direction of the current and in alignment with the flow of water that passed out from the lower end of the upper pool. The examination of Plates 87 and 88, made before and after dredging, shows that the depth over the bar was increased between 3½ and 4 feet and that the cuts seem to have been properly located.

The total cost of the work on this bar by the dredge *Delta* was $2,175.83.

RESULTS.

The results of the operations of the four dredges clearly indicate the feasibility of the scheme of maintaining a 9-foot channel in the Mississippi River below Cairo, Ill., during any usual low-water stage after the necessary plant is made available. During the past season several places remained shoal for some days, as it was impossible for four dredges to immediately handle the work in hand, which was greater than usual this year, owing to the extreme low stage of the river for about fifty days, from September 20 to November 10, the New Madrid gauge reading as low as 1.5 feet and the Memphis gauge reading 0.3 foot. The previous low-water season the New Madrid gauge only read as low as 5 feet and the Memphis gauge 1¾ feet.

Eight dredges would seem sufficient to do the work required under usual conditions. If the river should fall very suddenly, there might not be time to work at each bar before the depth would be less than 9 feet, but it is thought that all the bars requiring dredging could be improved to the required depth in two weeks at the maximum.

There was 7 feet of water in the channels from Cairo to Memphis during the low water, except from September 20 to November 10, when there was 6 and 6½ feet at Phillips and Batsells, about half of this time being full 6.5 feet at both places. For a few days (about October 15) there was only 6 feet at Hathaways, and for four days 6 feet at Rocky Point, about October 18. Osceola Bar had only 6½ feet on October 28, and Island No. 34 (lower reef) 6½ feet. About October 21 the shoals formed suddenly, owing to the rapid fall in the river, and the dredges could not reach them in time. At all other places there was 7½ feet, except at Fillmore City (3), where there was only 7 feet while the channel was changing from the upper to the lower way. There was only 7 feet at Point Pleasant for a few days, when the *Beta* could not drop over the reef, and had to call on the *Gamma* for assistance.

During the next low-water season it is suggested that the river between Cairo and Memphis be divided into three districts for dredging operations and that the fourth district include all work required below Memphis; each district to be patrolled by a surveyor with a survey party quartered on a small tender, and the dredges in his district to be under his immediate charge; the entire work to be under the superintendent of dredging operations, as before.

There will be six instead of four dredging plants, and the superintendent can not visit all bars as often as is required. The surveyors will therefore make intermediate surveys during the work at each bar, thus keeping the dredge employed at the most difficult part of the channel. Dredging has been sometimes continued at certain parts of a channel where not positively necessary and when the dredge should have been working at a more narrow or shoal portion. The survey parties should start out at about the time the New Madrid gauge reads 17 feet and establish base lines and make preliminary surveys of all bars in their respective districts. Then another survey should be made of each bar just before dredging, and by comparing the two maps the natural tendencies of the channel can be much better determined than if only the map of the latter survey is available.

The division of the river into districts, under the supervision of surveyors, will increase the effective work of the dredges and simplify the requisition of supplies, rendering of accounts, and administration in general.

There is transmitted herewith inclosed Plate 91, abstract of expenditures showing the cost for all classes of work from June 1, 1897, to April 30, 1898.

Respectfully submitted.

C. W. STURTEVANT,
Assistant Engineer, Superintendent of Dredging Operations.

Capt. H. E. WATERMAN,
Corps of Engineers, U. S. A., Secretary, Mississippi River Commission.

PLATE NO. 21.—*Record of capacity tests of U. S. dredge Gamma.*

No. of test.	Date.	Duration of test.	Conditions.[a]		Forward movement of dredge per minute.	Main engine and pump.					
			Depth of water.	Depth of suction.		Steam pressure, pounds per square inch.	Vacuum in condenser, inches of mercury.	Revolutions per minute.	I. H. P.		
									High-pressure cylinder.	Low-pressure cylinder.	Total.
	1897.	*Secs.*	*Feet.*	*Feet.*	*Feet.*						
1	Aug. 13, 9.15 a. m	80.4	5.2	14	2.0	143	25.5	162	239.8	265.6	505.4
2	Aug. 13, 11.10 a. m ...	90.8	7.0	14	3.9	135	25.0	176	212.7	266.6	479.3
3	Aug. 13, 1.45 p. m	105.3	4.7	12	2.2	152	25.5	174	229.7	256.5	486.2
4	Aug. 13, 3.50 p. m	81.2	4.0	11	1.8	162	25 0	163	215.6	221.3	436.9
5	Aug. 14. 11.10 a. m ...	59.5	5.2	12	4.5	144	25.5	172	242.2	270.0	512.2
6	Aug. 14, 1.55 p. m	40.6	4.3	12	5.2	139	26.0	165	228.6	249.0	477.6
7	Aug. 14, 3.40 p. m	64.7	4.3	12	3.5	145	26.5	166	....	....	....
8	Aug. 16, 9.30 a. m	67.2	4.8	11	5.6	130	26.0	170	225.3	257.3	482.6
9	Aug. 16, 11.50 a. m ...	69.7	5.8	15	2.3	140	24.0	166	240.0	240.6	480.6
10	Aug. 16, 1.50 p. m	97.6	5.2	15	3.2	143	25.0	167	....	....	....
11	Aug. 16, 3.40 p. m	64.4	5.2	11	6.6	125	26.7	169	225.4	282 1	507.5
	Average.......	74.67	5.06	12.6	3.71	141.6	25.52	168.2	228.81	256.56	485.37
	Special test.										
12	Aug. 17, 11.15 a. m ...	68.8	6.3	11	2.2	142	24	170	239	265.2	504.2

No. of test.	Date.	Main engine and pump.				Jet engine and pump. (Nine jets 2¼ inches diameter.)					
		Head.				Revolutions per minute.	I. H. P.			Head.	
		Suction, feet of water.	Discharge, feet of water.	Velocity, feet of water.	Total, feet of water.		High-pressure cylinder.	Low-pressure cylinder.	Total.	Suction, feet of water.	Discharge, feet of water.
	1897.										
1	Aug. 13, 9.15 a. m	10.3	29.3	2.1	41.7	148	60.4	26.8	87.2	3.7	31.6
2	Aug. 13, 11.10 a. m ...	8.0	35.0	1.8	44.8	146	56.6	26.0	82.6	4.0	31.6
3	Aug. 13, 1.45 p. m	8.0	38.5	1.1	47.6	143	54.1	23.5	77.6	3.7	31.1
4	Aug. 13, 3.50 p. m	7.5	30.9	2.0	40.4	144	55.3	24.5	79.8	3.7	30.6
5	Aug. 14, 11.10 a. m ...	9.4	35.0	1.7	46.1	146	55.6	26.4	82.0	3.7	31.3
6	Aug. 14, 1.55 p. m	9.6	38.7	1.5	49.8	144	53.0	24.2	77.2	3.8	33.4
7	Aug. 14, 3.40 p. m	9.2	41.5	1.0	51.7	142	49.4	22.4	71.8	3.8	31.3
8	Aug. 16, 9.30 a. m	8.6	41.5	1.4	51.5	158	63.7	31.0	94.7	4.0	31.6
9	Aug. 16, 11.50 a. m ...	8.0	33.9	1.8	43.7	160	66.1	32.7	98.8	5.2	34.0
10	Aug. 16, 1.50 p. m	14.3	45.4	.4	60.1	165	74.1	38.3	112.4	4.2	36.8
11	Aug. 16, 3.40 p. m	10.3	37.3	1.8	49.4	160	68.1	34.7	102.8	4.2	38.2
	Average.......	9.38	37	1.51	47.89	150.5	59.67	28.23	87.90	4.0	32.86
	Special test.										
12	Aug. 17, 11.15 a. m ...	8.6	30.4	2.6	41.6	....	....	....	....	....	....

[a] Suction pipes: Two, 24 inches diameter; length from mouth to pump, 48 feet. Discharge pipe: Diameter, 34 inches: length from stern of dredge to valve in barge, 987.1 feet. Length from pump to valve in barge = 1069 feet. Advance of dredge per revolution of winding engines, $\frac{1}{25}$ foot.

PLATE No. 21.—*Record of capacity tests of U. S. dredge Gamma*—Continued.

No. of test.	Date.	Measuring barge. (Area of water = 2,558.7 square feet, area of sand = 2,532.5 square feet.)									
		Mean depth of water in barge before test.	Mean depth of material in barge at end of test.	Mean depth of material pumped.	Quantity of material pumped.	Quantity per second.	Velocity of discharge per second.	Mean depth of sand.	Quantity of sand.	Percentage of sand.	Sand pumped, rate per hour.
	1897.	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Feet.*	*Feet.*	*Cu. ft.*		*Cu. yds.*
1	Aug. 13, 9.15 a. m	0.487	2.783	2.296	5,874.8	73.07	11.59	0.332	840.8	14.3	1,394.0
2	Aug. 13, 11.10 a. m ...	.421	2.800	2.379	6,089.7	67.07	10.64	.379	961.5	16.0	1,411.9
3	Aug. 13, 1.45 p. m	.767	2.967	2.200	5,629.1	53.46	8.48	.352	892.0	15.8	1,129.5
4	Aug. 13, 3.50 p. m	.375	2.650	2.275	5,821.0	71.69	11.37	.187	473.6	8.1	776.2
5	Aug. 14, 11.10 a. m ...	.417	1.967	1.550	3,966.0	66.66	10.57	.347	878.8	22.2	1,967.4
6	Aug. 14, 1.55 p. m	.317	1.296	.979	2,507.5	61.76	9.79	.214	542.0	21.6	1,780.0
7	Aug. 14, 3 40 p. m	.367	1.617	1.250	3,198.4	49.43	7.84	.270	683.8	21.4	1,410.9
8	Aug. 16, 9.30 a. m	.290	1.850	1.560	3,991.6	59.40	9.42	.436	1,101.0	27.6	2,184.5
9	Aug. 16, 11.50 a. m ...	.267	2.117	1.850	4,733.6	67.91	10.77	.247	625.5	13.2	1,194.6
10	Aug. 16, 1.50 p. m	.345	1.583	1.238	3,167.7	32.46	5.15	.263	666.0	21.0	909.6
11	Aug. 16, 3.40 p. m	.379	2.067	1.688	4,319.1	67.07	10.64	.495	1,253.2	29.0	2,595.2
	Average.......	.403	2.1543	1.7514	4,481.68	60.907	9.660	.3202	810.75	19.11	1,523.09
	Special test.										
12	Aug. 17, 11.15 a. m ...	.533	2.575	2.042	5,224.9	81.89	12.99	.136	344	6.6	718.9

No. of test.	Date.	Efficiency.				Weight of a cubic foot of dry sand.	Percentage of voids.	Remarks.
		Work done per second, measured by material pumped.	Work done per second, measured by indicator cards.	Efficiency, per centum.	Sand pumped per hour, per I. H. P.			
	1897.	*Ft. lbs.*	*Ft. lbs.*		*Cu. yds.*	*Pounds.*		
1	Aug. 13, 9.15 a. m	190,438	277,970	68.5	2.76	98.5	37.2	
2	Aug. 13, 11.10 a. m ...	187,796	263,615	71.2	2.95	99.0	36.7	
3	Aug. 13, 1.45 p. m	159,043	267,410	59.5	2.32	105.5	32.8	
4	Aug. 13, 3.50 p. m	181,017	240,295	75.3	1.78	99.0	37.3	Experiment with light load.
5	Aug. 14, 11.10 a. m ...	192,064	281,710	68.2	3.84	103.5	35.7	
6	Aug. 14, 1.55 p. m	192,228	262,680	73.2	3.73	101.5	34.6	
7	Aug. 14, 3.40 p. m	a159,721	....	....	....	103.0	34.4	No indicator cards were taken.
8	Aug. 16, 9.30 a. m	191,194	265,430	72.0	4.53	105.0	34.0	
9	Aug. 16, 11.50 a. m ...	185,479	264,330	70.2	2.49	99.5	33.2	
10	Aug. 16, 1.50 p. m	a121,928	....	....	....	107.0	32.8	Pipes sunk at test. No indicator cards were taken.
11	Aug. 16, 3.40 p. m	207,079	279,125	74,2	5.11	106.0	36.3	
	Average.......	187,370.9	266,951.7	70.26	3.28	102.5	35.0	
	Special test.							
12	Aug. 17, 11.15 a. m ...	212,914	277.310	76.8	1.48	100.0	36.9	Jets not in operation.

[a] Not used in computing average.

PLATE NO. 22.—*Record of capacity tests of U. S. dredge Delta.*

No. of test.	Date and hour.	Duration of test.	Conditions.a							Speed of cutters, revolutions per minute.	Forward movement of dredge per minute.
			Suction pump.				Discharge pipe.				
			Length from mouth to pump.	Diameter.	Depth of water.	Depth of suction.	Diameter.	Length from stern of dredge to valve in barge.	Length from pump to valve in barge.		
	1897.	*Secs.*	*Feet.*	*Inches.*	*Feet.*	*Feet.*	*Inches.*	*Feet.*	*Feet.*		*Feet.*
1	Aug. 2, 4.40 p. m	77.0	84.6	34	6.0	11.2	34	984.5	1,104.5	7.7	3.9
2	Aug. 3, 1.05 p. m	62.5	84.6	34	5.8	11.2	34	984.5	1,104.5	9.0	4.4
3	Aug. 3, 3.50 p. m	71.5	84.6	34	7.0	12.1	34	984.5	1,104.5	7.6	6.0
4	Aug. 4, 11.45 a. m	79.0	84.6	34	6.7	12.1	34	984.5	1,104.5	9.3	3.8
5	Aug. 4, 3.20 p. m	75.5	84.6	34	8.3	14.2	34	984.5	1,104.5	7.7	2.7
6	Aug. 5, 11.25 a. m	61.0	84.6	34	5.3	12.5	34	984.5	1,104.5	9.7	4.2
7	Aug. 5, 2.44 p. m	59.25	84.6	34	......	......	34	984.5	1,104.5	......	5.1
8	Aug. 6, 2.02 p. m	61.0	84.6	34	7.0	12.7	34	984.5	1,104.5	9.4	4.4
9	Aug. 6, 4.15 p. m	60.0	84.6	34	7.8	13.3	34	984.5	1,104.5	9.2	5.4
10	Aug. 7, 9.38 a. m	60.5	84.6	34	7.0	15.0	34	984.5	1,104.5	7.0	3.8
11	Aug. 7, 1.25 p. m	58.0	84.6	34	6.3	15.0	34	984.5	1,104.5	8.2	2.5
12	Aug. 7, 4.55 p. m	60.5	84.6	34	10.0	13.5	34	984.5	1,104.5	7.9	4.3
13	Aug. 9, 9.45 a. m	61.0	84.6	34	9.5	14.8	34	984.5	1,104.5	7.4	2.6
14	Aug. 9, 11.30 a. m	72.0	84.6	34	10.0	14.5	34	984.5	1,104.5	7.9	2.8
	Average	65.63	84.6	34	7.44	13.24	34	984.5	1,104.5	8.30	3.99
	Average, excluding tests Nos. 4, 6, and 8									7.96	3.95
	Special tests.										
15	Aug. 9, 2.20 p. m	53.0	84.6	34	10.5	13.5	34	532.0	652.0	9.6	5.2
16	Aug. 11, 11.35 a. m	60.0	84.6	34	8.0	13.3	34	984.5	1,104.5	......	3.8

No. of test.	Date and hour.	Main engine and pump.									
		Steam pressure, pounds per square inch.	Vacuum in condenser, inches of mercury.	Revolutions per minute.	I. H. P.			Head.			
					High-pressure cylinder.	Low-pressure cylinder.	Total.	Suction, feet of water.	Discharge, feet of water.	Velocity, feet of water.	Total, feet of water.
	1897.										
1	Aug. 2, 4.40 p. m	159	24.0	150	498.5	536.6	1,035.1	17.0	46.4	4.1	67.5
2	Aug. 3, 1.05 p. m	156	23.3	151	....	....	....	18.7	45.3	4.2	68.2
3	Aug. 3, 3.50 p. m	156	23.0	149	....	....	....	18.1	45.3	3.8	67.2
4	Aug. 4, 11.45 a. m	156	23.0	151	496.7	534.2	1,030.9	19.2	54.5	2.3	76.0
5	Aug. 4, 3.20 p. m	156	23.5	150	491.7	505.2	996.9	18.1	47.6	3.5	69.2
6	Aug. 5, 11.25 a. m	160	23.0	149	532.4	566.2	1,098.6	19.8	45.3	3.4	68.5
7	Aug. 5, 2.44 p. m	161	23.0	152	492.0	490.1	982.1	19.2	47.6	3.0	69.8
8	Aug. 6, 2.02 p. m	160	24.2	149	461.9	456.3	918.2	17.0	47.6	3.7	68.3
9	Aug. 6, 4.15 p. m	161	23.5	150	536.6	553.3	1,089.9	23.2	38.4	3.0	64.6
10	Aug. 7, 9.38 a. m	156	23.3	149	....	....	......	19.2	43.0	3.5	65.7
11	Aug. 7, 1.25 p. m	161	23.0	152	543.1	553.7	1,096.8	18.1	41.8	3.7	63.6
12	Aug. 7, 4.55 p. m	156	23.8	151	515.5	530.3	1,045.8	17.5	43.0	3.3	63.8
13	Aug. 9, 9.45 a. m	156	23.0	154	517.4	554.9	1,072.3	17.5	45.3	3.4	66.2
14	Aug. 9, 11.30 a. m	156	23.0	154	522.3	546.9	1,069.2	18.1	46.4	3.5	68.0
	Average	157.9	23.33	150.8	509.8	529.8	1,039.6	18.62	45.54	3.46	67.61
	Average without tests, 4, 6, 8	157.6	23.31	151.1	514.6	533.9	1,048.5	18.61	44.55	3.55	66.71
	Special tests.										
15	Aug. 9, 2.20 p. m	156	22.8	146	511.0	523.3	1,034.3	21.5	33.8	5.3	60.6
16	Aug. 11, 11.35 a. m	161	23.2	149	490.4	501.9	992.3	18.1	38.4	3.9	60.4

a Forward movement of dredge per revolution of winding engines, $\frac{1}{32}$ foot. Ratio of speed of cutters to speed of cutter engine, $\frac{1}{23.9}$.

PLATE NO. 22.—*Record of capacity tests of U. S. dredge Delta*—Continued.

No. of test.	Date and hour.	Measuring barge. (Area of water=2,558.7 square feet; area of sand=2,532.5 square feet.)									
		Mean depth of water in barge before test.	Mean depth of water and sand in barge at end of test.	Mean depth of material pumped.	Quantity of material pumped.	Quantity per second.	Velocity of discharge per second.	Mean depth of sand.	Quantity of sand.	Percentage of sand.	Sand pumped, rate per hour.
	1897.	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Feet.*	*Feet.*	*Cu. ft.*		*Cu. yds.*
1	Aug. 2, 4.40 p. m.....	0.396	3.467	3.071	7,857.8	102.05	16.19	0.398	1,007.9	12.8	1,745.3
2	Aug. 3, 1.05 p. m.....	.417	2.958	2.541	6,501.7	104.03	16.50	.300	759.8	11.7	1,620.9
3	Aug. 3, 3.50 p. m.....	.338	3.083	2.745	7,026.2	98.27	15.59	.471	1,192.8	17.0	2,224.3
4	Aug. 4, 11.45 a. m....	.496	2.850	2.354	6,023.2	76.24	12.09	.427	1,080.5	17.8	1,823.7
5	Aug. 4, 3.20 p. m.....	.383	3.167	2.784	7,123.4	94.35	14.96	.208	526.8	7.4	928.0
6	Aug. 5, 11.25 a. m....	.571	2.783	2.212	5,659.8	92.78	14.71	.439	1,111.8	19.6	2,432.4
7	Aug. 5, 2.44 p. m.....	.362	2.408	2.046	5,235.1	88.36	14.01	.518	1,311.8	25.1	2,949.2
8	Aug. 6, 2.02 p. m.....	.583	2.900	2.317	5,928.5	97.19	15.41	.180	455.8	7.7	995.0
9	Aug. 6, 4.15 p. m.....	.575	2.633	2.058	5,265.8	87.76	13.92	.375	950.1	18.0	2,111.3
10	Aug. 7, 9.38 a. m.....	.429	2.667	2.238	5,726.4	94.65	15.01	.576	1,457.7	25.5	3,212.4
11	Aug. 7, 1.25 p. m.....	.450	2.650	2.200	5,629.1	97.05	15.39	.317	802.8	14.3	1,853.2
12	Aug. 7, 4.55 p. m.....	.512	2.700	2.188	5,598.4	92.54	14.68	.263	667.5	11.9	1,471.1
13	Aug. 9, 9.45 a. m.....	.342	2.567	2.225	5,693.1	93.33	14.80	.224	567.3	10.0	1,240.0
14	Aug. 9, 11.30 a. m....	.421	3.100	2.679	6,856.8	95.23	15.10	.215	544.7	7.9	1,000.9
	Average	.4482	2.8524	2.4041	6,151.77	93.845	14.883	.351	888.36	14.76	1,829.12
	Average without tests, 4, 6, 8	.4205	2.8545	2.4341	6,228.48	95.238	15.105	.3514	889.93	14.69	1,850.60
	Special tests.										
15	Aug. 9, 2.20 p. m.....	.308	2.716	2.408	6,166.5	116.35	18.45	.242	613.3	9.9	1,542.9
16	Aug. 11, 11.35 a. m...	.467	2.817	2.350	6,012.9	100.22	15.90	.227	574.0	9.5	1,277.5

No. of test.	Date and hour.	Efficiency.				Weight per cubic foot of dry sand.	Percentage of voids in wet sand.	Remarks.
		Work done per second, measured by material pumped.	Work done per second, measured by indicator cards.	Efficiency, percentum.	Sand pumped per hour, per I. H. P.			
	1897.	*Ft. lbs.*	*Ft. lbs.*		*Cu. yds.*	*Pounds.*		
1	Aug. 2, 4.40 p. m.....	430,523	569,305	75.6	1.69	98.5	37.2	
2	Aug. 3, 1.05 p. m.....	a443,428	....	....	....	76.5	37.2	No indicator cards were taken.
3	Aug. 3, 3.50 p. m.....	a412,734	....	....	....	94.5	37.2	Do.
4	Aug. 4, 11.45 a. m....	362,140	566,995	63.9	1.77	98.5	34.0	Test-barge valve not completely open.
5	Aug. 4, 3.20 p. m.....	408,064	548,295	74.4	.93	104.5	35.2	
6	Aug. 5, 11.25 a. m....	397,214	604,230	65.7	2.21	108.5	36.3	Test-barge valve did not close and open completely.
7	Aug. 5, 2.44 p. m.....	385,420	540,155	71.4	3.00	100.5	40.0	Cutter machinery broke at test.
8	Aug. 6, 2.02 p. m.....	414,880	505,010	82.1	1.08	115.5	36.2	Test-barge valve not completely open.
9	Aug. 6, 4.15 p. m.....	354,331	599,445	59.1	1.94	96.5	37.1	
10	Aug. 7, 9.38 a. m.....	a388,656	....	....	....	110.5	33.4	No indicator cards were taken.
11	Aug. 7, 1.25 p. m.....	385,773	603,240	63.9	1.69	100.5	37.5	
12	Aug. 7, 4.55 p. m.....	369,003	575,190	64.2	1.41	102.5	38.9	

a Not used in computing averages.

Plate No. 22.—*Record of capacity tests of U. S. dredge Delta*—Continued.

No of test.	Date and hour.	Efficiency.				Weight per cubic foot of dry sand.	Percentage of voids in wet sand.	Remarks.
		Work done per second, measured by material pumped.	Work done per second, measured by indicator cards.	Efficiency, percentum.	Sand pumped per hour, per I. H. P.			
	1897.	*Ft. lbs.*	*Ft. lbs.*		*Cu. yds.*	*Pounds.*		
13	Aug. 9, 9.45 a. m.	386,152	589,765	65.5	1.16	96.5	35.5	In sand with a small percentage of gravel.
14	Aug. 9, 11.30 a. m.	404,727	588,060	69.0	.94	112.5	35.4	Do.
	Average	390,747.9	571,790.0	68.62	1.620	101.14	36.51	
	Average without tests, 4, 6, 8	390,499.1	576,681.9	67.88	1.595	99.41	36.8	
	Special tests.							
15	Aug. 9, 2.20 p. m.	440,675	568,865	77.5	1.49	92.5	33.4	Discharge pipe 532 feet long, using cutters.
16	Aug. 11, 11.35 a. m.	378,330	545,765	69.3	1.29	110.5	34.9	Cutters removed from suction.

Plate No. 23.—*Main pumping engines of U. S. dredge Zeta.—Record during efficiency tests at New Madrid, Mo., January and February, 1898.*

[Ideal engine, size 16 and 26-inches by 18 inches.]

Series.	Revolutions per minute.	Steam pressure, pounds.	Heads.		I. H. P.					Revolutions of cutter engine per minute.
			Suction, feet of water.	Delivery, feet of water.	Starboard engine.		Port engine.		Total.	
					High-pressure cylinder.	Low-pressure cylinder.	High-pressure cylinder.	Low-pressure cylinder.		
1	178	140	11.9	28.5	228	128	174	188	658	....
2	187	152	11.9	26.5	238	119	207	178	742	....
3	182	152	11.5	25.5	225	97	195	165	682	....
4	180	152	13.5	28.5	241	110	204	165	720	147
5	179	151	12.4	28.5	233	110	197	158	698	120
6	180	151	12.9	28.5	231	115	191	154	691	135
7	179	146	14.0	27.5	232	109	195	158	694	105
8	180	156	12.9	28.5	222	101	184	149	656	156
9[a]	200	149	15.8	30.7	260	187	272	247	916	....

[a] Shaft broke outside of main journal on starboard engine two minutes after cards were taken.

After taking card No. 1, governor was changed to a more sensitive position.

PLATE No. 25.—*Record of capacity tests of U. S. dredge Epsilon.*

No. of test.	Date.	Duration of test.	Conditions.[a]		Forward movement of dredge per minute.	Main engine and pump.										
			Depth of suction.	Depth of water.		Steam pressure (pounds) per square inch.	Revolutions per minute.	I. H. P.					Head.			
								Starboard.		Port.		Total.	Suction, feet of water.	Discharge, feet of water.	Velocity, feet of water.	Total, feet of water.
								High pressure cylinder.	Low pressure cylinder.	High pressure cylinder.	Low pressure cylinder.					
	1898.	*Sec.*	*Ft.*	*Ft.*	*Ft.*											
1	Mar. 14, 2.45 p. m.	122.2	15	7.8	3.0	153	182	170.6	85.5	228.4	124.1	611.6	13.0	44.7	1.6	59.3
2	Mar. 15, 9.25 a. m.	102.5	15	8.5	3.0	160	181	194.8	101.8	232.4	113.0	642.0	15.8	34.7	3.4	53.9
3	Mar. 16, 4.02 p. m.	82.6	15	8.5	4.4	155	181	176.5	88.0	278.8	169.1	712.4	16.4	34.7	4.4	55.5
4	Mar. 17, 7.38 a. m.	54.5	14	7.3	5.8	155	182	233.0	136.2	260.7	145.8	775.7	18.1	37.7	3.8	59.6
5	Mar. 17, 9.25 a. m.	61.5	14	7.0	9.4	165	182	231.7	137.1	278.7	153.6	801.1	19.8	37.7	4.1	61.6
6	Mar. 17, 11.39 a. m	66.4	14	8.0	7.1	160	181	239.0	139.8	239.6	119.9	738.3	17.0	37.7	4.3	59.0
7	Mar. 17, 2.21½ p. m	57.5	15	9.0	.....	162	182	242.6	137.1	229.8	107.6	717.1	14.7	36.7	5.2	56.6
	Average, excluding tests Nos. 1 and 2.........	64.5	14.4	7.96	[b]6.67	159.4	181.6	224.56	127.64	257.52	139.20	748.92	17.2	36.9	4.36	58.46

No. of test.	Date.	Jet pump.		Measuring barge. (Area of water=2,558.7 square feet; area of sand=2,532.5 square feet.)									
		Revolutions per minute.	Head.	Mean depth of water in barge before test.	Mean depth of material in barge at end of test.	Mean depth of material pumped.	Quantity of material pumped.	Quantity per second.	Velocity of discharge, per second.	Mean depth of sand.	Quantity of sand.	Percentage of sand.	Sand pumped, rate per hour.
			Discharge, feet of water.										
	1898.			*Feet.*	*Feet.*	*Feet.*	*Cu. feet.*	*Cu. ft.*	*Feet.*	*Feet.*	*Cu. feet.*		*Cu. yds.*
1	Mar. 14, 2.45 p. m..	188	22.1	0.600	3.333	2.733	6,992.9	57.22	10.2	0.274	693.9	9.9	757.1
2	Mar. 15, 9.25 a. m..	200	26.7	.417	3.700	3.283	8,400.2	81.95	14.7	.217	549.6	6.5	714.9
3	Mar. 16, 4.02 p. m..	191	24.4	.433	3.483	3.050	7,804.0	94.48	16.9	.419	1,061.1	13.6	1,712.8
4	Mar. 17, 7.38 a m..	224	31.3	.750	2.617	1.867	4,777.1	87.65	15.7	.464	1,175.1	24.6	2,874.9
5	Mar. 17, 9.25 a. m..	232	32.5	.300	2.467	2.167	5,544.7	90.16	16.4	.565	1,430.9	25.8	3,102.2
6	Mar. 17. 11.39 a. m.	228	32.5	.500	2.900	2.400	6,140.9	92.48	16.6	.555	1,405.5	22.9	2,822.3
7	Mar. 17, 2.21½ p. m.	140	35.6	.367	2.667	2.300	5,885.0	102.35	18.3	.384	972.5	16.5	2,255.1
	Average, excluding tests Nos. 1 and 2.........	203.0	31.26	.470	2.8268	2.3568	6,030.34	93.424	16.78	.4774	1,200.02	20.68	2,553.46

[a] Suction pipes: Two, 24 inches in diameter; length from mouth to pump, 69 feet. Discharge pipe: Diameter, 32 inches; length from stern of dredge to valve in barge, 1,036 feet; length from pump to valve in barge, 1,121 feet.

[b] Average of Nos. 3 to 6.

PLATE NO. 25.—*Record of capacity tests of U. S. dredge Epsilon*—Continued.

No. of test.	Date.	Efficiency.				Weight of a cubic foot of dry sand.	Percentage of voids.	Remarks.
		Work done per second, measured by material pumped.	Work done per second, measured by indicator cards.	Efficiency, per centum.	Sand pumped per hour, per I. H. P.			
	1898.	*Foot-lbs.*	*Foot-lbs.*		*Cu. yds.*	*Pounds.*		
1	Mar. 14, 2.45 p. m.	212, 072	336, 380	63. 0	1. 24	106. 0	33. 3	Mud lumps in barge, not average material.
2	Mar. 15, 9.25 a. m.	276, 069	353, 100	78. 2	1. 11	103. 0	32. 8	Do.
3	Mar. 16, 4.02 p. m.	327, 728	391, 820	83. 6	2. 40	100. 2	36. 1	Medium fine sand.
4	Mar. 17, 7.38 a. m.	326, 496	426, 635	76. 5	3. 71	103. 2	33. 1	Do.
5	Mar. 17, 9.25 a. m.	347, 116	440, 605	78. 8	3. 87	97. 5	36. 5	Do.
6	Mar. 17, 11. 39 a. m.	341, 020	406, 065	84. 0	3. 82	97. 8	35. 3	Do.
7	Mar. 17, 2.21½ p. m.	362, 063	394, 405	91. 8	3. 14	99. 2	35. 8	Do.
	Average, excluding tests Nos. 1 and 2	340, 884. 6	411, 906. 0	82. 9	3. 388	99. 58	35. 36	

PLATE NO. 27.—*Record of capacity tests of U. S. dredge Zeta.*

No. of test.	Date.	Duration of test.	Conditions.a		Forward movement of dredge per minute.	Revolutions of cutter engine per minute.	Main engine and pump.						
			Depth of suction.	Depth of water.			Steam pressure pounds per square inch.	Revolutions per minute.	I. H. P.				
									Starboard.		Port.		Total.
									High pressure cylinder.	Low pressure cylinder.	High pressure cylinder.	Low pressure cylinder.	
	1898.	*Secs.*	*Feet.*	*Feet.*	*Feet.*								
1	Mar. 21, 2.25 p. m.	62. 0	14	7. 5	4. 8	120	145	182	224. 5	137. 1	197. 2	159. 6	718. 4
2	Mar. 22, 12.09½ p. m.	60. 0	13	7. 5	6. 0	186	150	182	218. 8	120. 6	197. 5	152. 7	689. 1
3	Mar. 23, 9.25 a. m.	69. 6	13	6. 0	4. 0	155	146	182	225. 2	122. 3	189. 3	141. 4	678. 2
4	Mar. 24, 11.15 a. m.	70. 0	14	8. 0	3. 2	183	146	181	215. 4	119. 1	186. 7	139. 8	661. 0
5	Mar. 24, 1.37 p. m.	61. 6	14	8. 5	5. 0	180	144	180	222. 7	129. 6	191. 5	144. 2	688. 0
	Average	64. 64	13. 6	7. 5	4. 6	164. 8	146. 2	181. 4	221. 22	125. 74	192. 44	147. 54	686. 94

a Suction pipes: Two, 24 inches in diameter; length from mouth to pump, 69 feet. Discharge pipe: Diameter, 32 inches; length from stern of dredge to valve in barge, 1,036 feet; length from pump to valve in barge, 1,121 feet.

PLATE No. 27.—*Record of capacity tests of U. S. dredge Zeta*—Continued.

No. of test.	Date.	Main engine and pump.				Measuring barge. (Area of water=2,558.7 square feet; area of sand=2,532.5 square feet.)									
		Head.													
		Suction, feet of water.	Discharge, feet of water.	Velocity, feet of water.	Total, feet of water.	Mean depth of water in barge before test.	Mean depth of material in barge at end of test.	Mean depth of material pumped.	Quantity of material pumped.	Quantity per second.	Velocity of discharge per second.	Mean depth of sand.	Quantity of sand.	Percentage of sand.	Sand pumped, rate per hour.
	1898.					*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Feet.*	*Feet.*	*Cu. ft.*		*Cu. yds.*
1	Mar. 21, 2.25 p. m	13.0	34.7	4.5	52.2	0.417	2.717	2.300	5,885.0	94.92	17 0	0.345	873.7	14.8	1,878.9
2	Mar. 22, 12.09½ p. m	12.4	35.7	3.3	51.4	.650	2.567	1.917	4,905.0	81.75	14.6	.231	585.0	11.9	1,300.0
3	Mar. 23, 9.25 a. m	10.2	35.7	4.2	50.1	.317	2.817	2.500	6,396.8	91.91	16.5	.274	693.9	10.8	1,329.4
4	Mar. 24, 11.15 a. m	10.7	35.7	4.9	51.3	.433	3.150	2.717	6,952.0	99.31	17.8	.222	562.2	8.1	1,070.9
5	Mar. 24, 1.37 p. m	11.3	33.7	4.2	49.2	.433	2.650	2.217	5,672.6	92.09	16.5	.227	574.9	10.1	1,244.4
	Average.	11.52	35.1	4.22	50.84	.450	2.7802	2.3302	5,962.3	91.996	16.48	.2598	657.94	11.14	1,364.72

No. of test.	Date.	Efficiency.				Weight of a cubic foot of dry sand.	Percentage of voids.	Remarks.
		Work done per second, measured by material pumped.	Work done per second, measured by indicator cards.	Efficiency, per centum.	Sand pumped per hour, per I. H. P.			
	1898.	*Foot-lbs.*	*Foot-lbs.*		*Cu. yds.*	*Pounds.*		
1	Mar. 21, 2.25 p. m	309,677	395,120	78.4	2.62	100.0	36.1	Medium fine sand. Sheared 4 pins before test was obtained.
2	Mar. 22, 12.09½ p. m.	262,622	379,005	69.4	1.89	95.0	37.5	Medium fine sand. Test made after shearing 4 pins, only one agitator running.
3	Mar. 23, 9.25 a. m	287,793	373,010	77.2	1.96	94.5	35.9	Medium fine sand. Test made after shearing 2 pins.
4	Mar. 24, 11.15 a. m	318,413	363,550	87.6	1.62	95.0	36.6	Medium fine sand. Test made after shearing 5 pins and with only one agitator running.
5	Mar. 24, 1.37 p. m	283,177	378,400	74.8	1.81	93.0	35.5	Medium fine sand. No pins sheared.
	Average	292,336	377,817	77.5	1.98	95.5	36.32	

PLATE No. 29.—*Division of time of efficiency tests of the U. S. dredge Epsilon.*

Date.	Placing plant.	Dredging.	Changing cuts.	Repairs.	Making up tow and towing.	Capacity tests.	Sundays and holidays, etc. *a*	Total.
1898.	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*
Jan. 10	14¼	5		4¾				24
11		8	16					24
12		23½	½					24
13		23	1					24
14		17½	6½					24
15		11¼	6¾				6	24
16		6					18	24
17		19			5			24
18	6	6			12			24
19		23½	½					24
20		22	¾	1¼				24
21		18¼	¾	5				24
22		18					6	24
23		5½	½				18	24
24		13¼	1¼	9½				24
25				18			6	24
Feb. 10	2½	10½		1	1		9	24
11		23¼	¼	½				24
12		18					6	24
Mar. 13		10				14		24
14						24		24
15						24		24
16						24		24
17						24		24
18		15¼	8¾					24
19		17¼	¾				6	24
20		6					18	24
21		22½	1½					24
22		22½	1½					24
23		19¾	4¼					24
24		15¼	2¼	6½				24
25		22¾	1¼					24
26		17¼	¾				6	24
27	6						18	24
28	6	16⅞					1⅛	24
Total	34¾	456⅞	55¾	46½	18	110	118⅛	840

Total duration of efficiency tests, 35 days; percentage of "lost time" to "available dredging time," considering only first 30 days, 10.32.

a Includes certain authorized stoppages for which contractor was not responsible.

Division of time of efficiency tests of the U. S. dredge Zeta.

Date.	Placing plant.	Dredging.	Changing cuts.	Repairs.	Making up tow and towing.	Capacity tests.	Sundays and holidays, etc. *a*	Total.
1899.	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*
Jan. 10	12	5¼	6¼	½				24
11		23⅝	⅜					24
12		22¼	1¾					24
13		22¼	1½	¼				24
14		21	¾	2¼				24
15		10½	1	6½			6	24
16		3½			2½		18	24
17							24	24
18							24	24
19	3¾	3½		9¾			7	24
20		21¾	1	1¼				24
21		23½		½				24
22		17½	½				6	24
23		6					18	24
24		7½		10½			6	24
25		7					17	24
Feb. 10		3½					20½	24
11							24	24
12							24	24
Mar. 18	1¼	5				17¾		24
19						24		24
20							24	24
21	2½			2¾		18¾		24
22	7¼			1½		15¼		24
23	7⅜		2⅞			13¾		24
24	6			¾		17¼		24
25		17½	¼	¼			6	24
26		17½	¼	¼	2		4	24
27							24	24
28	1¼	11¼			4		7½	24
Total	41⅜	249⅞	16½	37	8½	106¾	260	720

Total duration of efficiency tests, 30 days; percentage of "lost time" to "available dredging time," 14.82.

a Includes certain authorized stoppages for which contractor was not responsible.

PLATE No. 89.—*Summary of dredging operations, Mississippi River, between Cairo and Graves Bayou (250), during low-water season of 1897.*

Name of dredge, locality, etc.	Results and conditions of work.														Dredged area.		
	Number of bars.	Number of cuts.	Total length of cuts.	Rate of advance per hour.	Depth of suction.	Depth of water 25 feet ahead.	Depth of water at stern.	Depth of material removed.	Suction head, water.	Delivery head, water.	Main pump, revolutions per minute.	Steam pressure.	Cutter or jet pump engine, revolutions per minute.	Discharge pressure, jet pump.	Length.	Mean width.	Contents.
ALPHA.			*Feet.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*		*Lbs.*			*Feet.*	*Feet.*	*Acres.*
Medleys Bar (30)	1	9	4,890	29.0	12.0	7.5	9.9	2.4	8.6	21.3	136.0	132.0	227.0	....	1,700	70.0	2.73
Phillips Bar (81)	1	8	2,960	32.5	11.5	7.3	9.7	2.4	7.5	23.0	140.0	133.0	230.0	....	520	98.0	1.17
Gold Dust Bar (158)	1	7	3,275	39.2	12.0	8.3	10.3	2.0	7.1	23.0	139.0	133.0	235.0	....	700	120.0	1.93
Fleeces Bar (243)	1	8	4,340	36.8	12.0	8.4	10.5	2.1	8.2	24.0	143.0	136.0	226.0	....	920	104.0	2.20
Total	4	32	15,465	....	....	....	....	....	....	....	....	....	....	....	....	....	8.03
Average	..	...	....	34.4	11.9	7.9	10.1	2.2	7.9	22.8	139.5	133.5	229.5	....	....	....	......
BETA.																	
Point Pleasant Bar (79)	1	19	8,077	52.9	15.0	9.3	13.0	3.7	14.0	20.8	128.6	172.0	84.6	....	2,600	141.3	8.66
Phillips Bar (81)	1	92	39,735	49.6	16.0	8.6	14.0	5.5	17.0	21.5	130.6	165.0	85.8	....	5,800	131.7	17.54
Total	2	111	47,812	....	....	....	....	....	....	....	....	....	....	....	....	....	26.20
Average	..	...	....	51.2	15.5	8.9	13.5	4.6	15.5	21.2	129.6	168.5	85.2	....	....	....	......
GAMMA.																	
Lazelles Bar (82.5)	1	8	4,818	27.3	15.0	10.1	14.4	4.3	6.5	18.5	145.0	132.0	133.0	7.5	1,300	155.0	4.64
Phillips Bar (81), first time	1	20	14,633	40.4	12.0	7.7	11.3	3.6	7.6	16.1	143.8	138.0	138.0	7.6	1,900	130.0	5.68
Upper Point Pleasant Bar (79)	1	4	4,410	45.5	12.0	8.5	11.8	3.3	6.7	18.8	150.8	140.0	135.0	7.1	1,080	195.0	4.82
Hathaways Bar (104)	1	10	8,065	36.4	12.0	7.9	11.5	3.6	6.1	19.1	140.8	151.0	135.0	7.1	2,500	153.0	8.78
Rocky Point Bar (160)	1	7	5,380	47.8	12.0	7.5	11.5	4.0	6.8	19.1	152.7	140.0	135.0	7.3	1,850	184.0	5.70
Batsells Bar (91)	1	5	3,945	86.7	12.0	8.6	11.9	3.3	8.5	....	150.0	139.0	135.0	7.4	850	198.0	3.86
Phillips Bar (81), second time	1	12	8,490	48.1	13.5	8.1	12.4	4.3	8.0	....	149.5	137.0	132.0	6.2	990	300.0	6.82
Total	7	66	49,741	....	....	....	....	....	....	....	....	....	....	....	....	....	40.30
Average	..	...	....	47.5	12.6	8.3	12.1	3.8	6.7	18.3	147.5	139.6	134.7	7.2	....	....	......
DELTA.																	
Island No. 34 Bar (179)	1	12	7,900	75.8	15.0	9.1	12.5	3.4	21.5	28.5	149.7	154.0	75.0	....	1,300	252.0	7.75
Island No. 40 Bar (211)	1	8	5,900	56.3	15.0	10.7	12.7	2.0	20.9	34.3	150.2	153.0	130.0	....	1,950	101.0	4.52
Presidents Island Bar (235)	1	5	1,750	21.8	11.0	6.7	8.1	1.4	22.6	32.0	150.8	155.0	120.0	....	1,420	53.0	1.72
Island No. 34 Bar (178)	1	4	3,350	82.7	15.0	8.7	12.6	3.9	19.2	29.7	149.7	154.0	140.0	....	850	160.0	3.12
Osceola Bar (164)	1	6	4,900	56.7	15.0	9.0	12.5	3.5	19.2	28.5	149.2	154.0	120.0	....	2,000	116.0	5.33
Graves Bayou Bar (250)	1	5	4,050	76.4	15.0	8.2	14.7	6.5	18.9	27.2	149.9	155.0	127.0	....	1,650	116.0	4.39
Total	6	40	27,850	....	....	....	....	....	....	....	....	....	....	....	....	....	36.88
Average	..	...	....	61.6	14.3	8.7	12.2	3.5	20.4	30.0	149.9	154.2	118.7	....	....	....	......
Grand total	19	249	140,868	....	....	....	....	....	....	....	....	....	....	....	....	....	101.36

PLATE No. 89.—*Summary of dredging operations, Mississippi River, between Cairo and Graves Bayou (250), during low-water season of 1897*—Continued.

Name of dredge, locality, etc.	Division of time by hours.										
	Date of commencement.	Date of completion.	Placing plant.	Dredging.	Changing cuts.	Repairs.	Passing boats.	Making up tow.	Towing.	Sundays and holidays.	Total number of hours.
ALPHA.											
Moving into field..	Oct. 8, 12 night..	Oct. 11, 12 night.	....	......	....	......	...	....	72	....	72
Medleys Bar (30)..	Oct. 11, 12 night.	Oct. 23, 12 night.	15	168½	11	51	...	6½	30	6	288
Phillips Bar (81) ..	Oct. 23, 12 night.	Nov. 1, 8 a. m....	31½	91	10	3	...	8½	56	....	200
Gold Dust Bar (158)	Nov. 1, 8 a. m....	Nov. 9, 4 p. m....	21	88½	3½	......	...	4	71	12	200
Fleeces Bar (243)..	Nov. 9, 4 p. m....	Nov. 18, 12 night	5½	118	5	16	...	6	35	38½	224
Moving to winter quarters.	Nov. 18, 12 night	Nov. 28, 12 night	....	......	....	......	...	....	240	....	240
Total.......	....	....	73	466	29½	70	...	25	504	56½	1,224
BETA.											
Moving into field..	Aug. 31, 12 night	Sept. 4, 7.30 a. m.	....	......	....	......	...	37¾	41¾	....	79½
Point Pleasant Bar (79).	Sept. 4, 7.30 a. m.	Sept. 29, 7 a. m...	50¼	152¾	22¼	13¼	...	4	2	355	599½
Phillips Bar (81) ..	Sept. 29, 7 a. m ..	Nov. 18, 12 night	26½	801	38¾	268¾	...	29	26	27	1,217
Moving to winter quarters.	Nov. 18, 12 night	Nov. 20, 12 night	....	......	....	......	...	12	36	....	48
Total.......	....	....	76¾	953¾	61	282	...	82¾	105¾	382	1,944
GAMMA.											
Moving into field..	Aug. 31, 12 night	Sept. 4, 8.30 a. m.	....	......	....	......	...	38¾	41¾	....	80½
Lazelles Bar (82.5).	Sept. 4, 8.30 a. m.	Sept. 16, 5 a. m...	39½	176¼	7½	28	...	5¾	7¾	19¾	284½
Phillips Bar (81), first time.	Sept. 16, 5 a. m ..	Oct. 14, 8.30 a. m.	9	362½	24¼	262	9½	7½	¾	....	675½
Upper Point Pleasant Bar (79).	Oct. 14, 8.30 a. m.	Oct. 19, 3.30 p. m.	3½	96¾	3	¼	...	5¼	18¼	....	127
Hathaways Bar (104).	Oct. 19, 3.30 p. m.	Oct. 31, 7 a. m....	3½	221½	12¾	¼	...	5½	36	....	279½
Rocky Point Bar (160).	Oct. 31, 7 a. m ...	Nov. 8, 9 a. m....	3½	112½	4½	......	5¾	10¾	57	....	194
Batsells Bar (91) ..	Nov. 8, 9 a. m....	Nov. 11, 2.30 p. m	2	45½	1½	......	...	4½	24	....	77½
Phillips Bar (81), second time.	Nov. 11, 2.30 p. m	Dec. 2, 3.15 p. m .	36½	208¼	6¾	47	6¼	17	15½	168	504¾
Awaiting developments and moving to winter quarters.	Dec. 2, 3.15 p. m .	Dec. 4, 4 p. m....	....	......	....	......	...	....	5	43¾	48¾
Total.......	....	....	97½	1,223¼	60½	337½	21¼	94¾	206	231½	2,272
DELTA.											
Moving into field..	Aug. 31, 12 night	Sept. 9, 10.45 a. m	....	......	....	......	...	38¼	164½	....	202¾
Island No. 34 Bar (179).	Sept. 9, 10.45 a. m	Sept. 18, 12.15 p. m	6¾	104¼	37¾	53¼	½	6¼	8¾	....	217½
Island No. 40 Bar (211).	Sept. 18, 12.15 p. m	Oct. 5, 12 noon...	16¾	107¼	23	150¼	...	11½	5½	93½	407¾
Presidents Island Bar (235).	Oct. 5, 12 noon...	Oct. 23, 3 p. m ...	8½	80¼	15	147½	15¼	14	87½	67	435
Island No. 34 Bar (178).	Oct. 23, 3 p. m ...	Oct. 28, 10.30 a. m	7¾	40½	7¼	12¼	½	4	25½	17¾	115½
Osceola Bar (164)..	Oct. 28, 10.30 a. m	Nov. 7, 1.45 p. m.	7½	86¾	17¼	46	...	8	77¾	....	243¼
Graves Bayou Bar (250).	Nov. 7, 1.45 p. m.	Nov. 18, 12 night	9	53	11	165	¼	8¼	9	18¾	274¼
Moving to winter quarters.	Nov. 18, 12 night	Nov. 28, 12 night	....	......	....	......	...	....	224	16	240
Total.......	....	....	56½	472	111¼	574¼	16½	90¼	602½	213	2,136
Grand total..	....	....	303½	3,115	262¼	1,263¾	37¾	292¾	1,418¼	883	7,576

PLATE No. 90.—*Abstract of expenditures during the low-water season of 1897.*

Boat.	Locality of work.	Labor.	Office supplies.	Subsistence.	Fuel.	Lighting supplies.
Dredge Alpha	Preparation and moving into field	$270.18	$4.00	$68.25	$165.50	$1.05
	Medleys Bar (30)	1,140.62	7.50	305.84	502.13	10.54
	Phillips Bar (81)	626.43	7.00	179.65	276.80	8.45
	Gold Dust Bar (158)	787.79	7.35	291.33	357.90	9.20
	Fleeces Bar (243)	733.82	7.25	304.74	357.90	9.20
	Towing to winter quarters	1,011.31	1.00	312.05	299.47	6.95
	Total	4,570.15	34.00	1,461.86	1,959.70	45.39
Dredge Beta	Preparation and moving into field	346.80	2.16	80.76	59.65	3.80
	Point Pleasant Bar (79)	3,024.59	6.00	670.17	1,603.05	15.00
	Phillips Bar (81)	5,179.40	28.00	1,506.93	5,678.02	72.00
	Towing to winter quarters	188.66	....	39.64	165.10	....
	Total	8,739.45	36.16	2,297.50	7,505.82	90.80
Dredge Gamma	Preparation and moving into field	284.91	1.04	67.28	72.77	2.55
	Lazelles Bar (82.5)	1,115.88	8.02	272.05	304.06	9.32
	Phillips Bar (81)	2,661.91	15.00	677.05	684.09	19.66
	Point Pleasant Bar (79)	546.43	2.30	143.65	153.89	2.95
	Hathaways Bar (104)	1,043.72	8.02	281.75	375.19	9.32
	Rocky Point Bar (160)	684.87	5.72	202.47	233.57	5.34
	Batsells Bar (91)	324.30	2.10	90.86	144.40	2.66
	Phillips Bar (81)	1,968.22	10.94	511.84	690.40	13.98
	Towing to winter quarters	635.73	3.01	64.27	18.21	3.02
	Total	9,265.97	56.15	2,311.22	2,676.58	68.80
Dredge Delta	Preparation and moving into field	819.98	1.25	270.16	75.42	1.10
	Lower Island 34 Bar (179)	901.55	3.75	294.58	281.71	3.60
	Island 40 Bar (211)	1,689.39	7.50	539.63	553.42	7.25
	Presidents Island Bar (235)	1,769.22	7.50	594.65	573.42	7.35
	Upper Island No. 34 Bar (178)	463.12	2.50	156.46	140.86	1.84
	Osceola Bar (164)	978.87	3.75	275.80	281.70	3.65
	Graves Bayou Bar (250)	1,064.40	5.00	287.59	281.72	3.75
	Towing to winter quarters	949.55	1.50	255.06	65.43	3.60
	Total	8,636.08	32.75	2,673.88	2,253.68	32.14
Steamer Minnetonka	Inspection boat	6,087.76	446.06	1,064.11	2,781.01	34.75
Steamer Vidalia	Survey boat	3,064.94	45.14	1,003.45	572.07	18.62
Steamer Search	do	2,606.33	82.36	708.83	271.00	1.30
	Grand total	42,970.68	732.62	11,520.85	18,019.86	291.80

PLATE NO. 90.—*Abstract of expenditures during the low-water season of 1897*—Cont'd.

Boat.	Locality of work.	Lubricants.	Miscellaneous supplies.	Hire of plant.	Total.
Dredge Alpha	Preparation and moving into field	$0.25	....	....	$509.23
	Medleys Bar (30)	26.30	$36.81	....	2,029.74
	Phillips Bar (81)	20.26	32.14	....	1,150.73
	Gold Dust Bar (158)	24.30	29.64	....	1,507.41
	Fleeces Bar (243)	24.35	30.88	....	1,468.14
	Towing to winter quarters	3.85	4.82	....	1,639.45
	Total	99.31	134.29	....	8,304.70
Dredge Beta	Preparation and moving into field	3.33	2.75	$114.00	613.25
	Point Pleasant Bar (79)	66.00	111.27	875.00	6,371.08
	Phillips Bar (81)	327.00	558.37	2,742.00	16,091.72
	Towing to winter quarters	.60	....	98.00	492.00
	Total	396.93	672.39	3,829.00	23,568.05
Dredge Gamma	Preparation and moving into field	2.00	....	130.00	568.55
	Lazelles Bar (82.5)	50.24	71.27	480.00	2,310.84
	Phillips Bar (81)	102.48	142.54	1,035.00	5,337.73
	Point Pleasant Bar (79)	19.85	30.63	220.00	1,119.70
	Hathaways Bar (104)	50.24	71.27	460.00	2,299.51
	Rocky Point Bar (160)	31.39	40.63	320.00	1,523.99
	Batsells Bar (91)	13.52	20.36	130.00	728.20
	Phillips Bar (81)	84.04	122.16	840.00	4,241.58
	Towing to winter quarters	4.93	....	100.00	829.17
	Total	358.69	498.86	3,715.00	18,951.27
Dredge Delta	Preparation and moving into field	2.00	....	416.50	1,586.41
	Lower Island 34 Bar (179)	17.76	27.80	416.50	1,947.20
	Island 40 Bar (211)	32.52	60.35	797.00	3,687.06
	Presidents Island Bar (235)	38.52	65.66	720.00	3,771.32
	Upper Island No. 34 Bar (178)	9.50	14.60	200.00	988.88
	Osceola Bar (164)	17.76	27.80	400.00	1,989.33
	Graves Bayou Bar (250)	19.76	33.61	480.00	2,175.83
	Towing to winter quarters	1.27	....	400.00	1,676.41
	Total	134.09	229.82	3,830.00	17,822.44
Steamer Minnetonka	Inspection boat	24.62	116.34	....	10,554.65
Steamer Vidalia	Survey boat	4.75	77.84	....	4,786.81
Steamer Search	do	38.02	179.45	....	3,887.29
	Grand total	1,056.41	1,908.99	11,374.00	87,875.21

PLATE NO. 91.—*Abstract of expenditures, United States dredging fleet, from June 1, 1897, to April 30, 1898.*

Care of plant		$35,002.90
Repairs to plant:		
Dredge Alpha	$8,573.13	
Beta	13,037.61	
Gamma	814.96	
Delta	2,209.48	
Epsilon	243.77	
Zeta	251.72	
Steamer Minnetonka	1,859.83	
Mississippi	151.58	
Vidalia	20.75	
Search	844.76	
Vulcan	233.60	
Pile Sinker No. 21	113.42	
No. 61	4.30	
No. 971	449.61	
No. 981	9.72	
No. 982	6.84	
Measuring barge	565.98	
Barge No. 201	14.72	
No. 208	99.60	
No. 211	78.17	
No. 214	14.43	
No. 215	50.80	

Repairs of plant—Continued.			
Barge No. 228		$58.69	
Skiffs		156.56	
			$29,863.43
Testing new dredges:			
Dredge Gamma		9,289.00	
Delta		5,975.45	
Epsilon		9,198.96	
Zeta		7,532.83	
			31,996.24
Field operations:			
Dredging—			
Alpha	$8,304.70		
Beta	23,568.05		
Gamma	18,951.27		
Delta	17,822.44		
		68,646.48	
Inspection (Minnetonka)		10,554.65	
Surveys—			
Vidalia	4,786.81		
Search	3,887.29		
		8,674.10	
			87,875.21
Tools and appliances			10,642.07
Total			195,379.85

APPENDIX 1 F.

REPORT OF ASSISTANT ENGINEER C. W. STURTEVANT, ON TESTS OF UNITED STATES DREDGE ALPHA.

UNITED STATES DREDGE FLEET, *New Madrid, Mo., June 9, 1898.*

CAPTAIN: I have the honor to submit the following report upon the tests of the dredge *Alpha*, made during the week commencing May 30, and ending June 4, 1898:

The tests were made opposite the foot of Island No. 10, about 5 miles above New Madrid, Mo., at the same place the capacity tests of the *Epsilon* and *Zeta* were made.

The *Vidalia* commenced to move the plant into position on May 30. The pipes were coupled up and the first test made on June 1.

The results of these tests are shown on plate No. 92, herewith. The following remarks are added, describing each test, viz:

Test No. 1 was made, pumping clear water through 525 feet of floating pipe.

Test No. 2 was made while pumping sand through 525 feet of pipe. The edges of the flat-top pipes were submerged 1½ inches. As the indicator cards did not show a well-defined point of cut-off, the cover of the high-pressure valve chest was removed and the valve rod found to be badly bent and the edges of the riding cut-off valves not square with ports of the high-pressure valve. The cut-off valves were removed and the connecting rod unshipped, and the remainder of the tests made with the cut-off valves removed from the engine.

Test No. 3 was made through 1,057 feet of floating pipe, the edges of the flat pipes being just submerged.

Test No. 4 was made through 1,057 feet of floating pipe, under conditions apparently, at the time, similar to test No. 3. About one minute after test was over the pipes commenced to sink by a wave of sand starting at the dredge. The suction pipe was hoisted and several pieces of decayed wood were found wedged in the strainer bars.

The low test may be partly accounted for by supposing that the decayed log was encountered by the suction about the moment of test and partially stopped the flow of water, causing the pipes to clog and not deliver the sand. The velocity was not very low, but the percentage was only 4.

In just what way the water could get into the barge, as usual, and not bring the sand with it, can not be explained. The flat pipes were loaded to nearly awash. The delivery head was the same as previous test. The suction head was higher, but the same as test No. 5, which gives about the same yardage as test No. 3. It is noted that the sand in this test is finer than in any of the others.

Test No. 5 was noted at time of test as being average conditions. Flat pipes one-half inch submerged.

Test No. 6, water test through 1,057 feet of pipe.

Test No. 7 was made after buoying up the flat pipes by placing the pontoons of the *Zeta* on either side and passing lines under the flat pipes. The three cylinder pipes were not buoyed.

All tests made after this were under the same conditions. About five minutes before the test the engine speeded up to 170 and was throttled down to 157 revolutions.

The delivery head was excessive during this test, and soon after the test the gauge failed to work, showing that the connecting pipe was clogged with sand. It was cleaned out after the test.

After examination of the cards the engineer moved the low-pressure eccentric, claiming it had slipped. I did not know of the change until after test No. 8, when I noticed the points on the cards and inquired about it. I then had it set back to its original place. Cards of test No. 7 show some change, but I think it was due to load and not to slipping of eccentric. In fact, the eccentric was moved in the wrong direction to eliminate the fault.

Test No 8 was made under usual conditions, except that the pipes were purposely overloaded to see what result could be obtained. Even the cylindrical pipes were totally submerged.

Test No. 9 was an average in appearances at time of test. At 8.10 a. m., twelve minutes before the test, the delivery head, which was 28.1 feet, suddenly dropped to 17.7 feet, owing, probably, to partial clogging of the pipe leading to gauge. I have calculated this test both ways, and think it proper to use the head shown twelve minutes before test. These results are specially indicated in the table.

Considerable trouble was caused by the delivery head gauge during test No. 8 and No. 9 from clogging of pipe, and results of efficiency may not be very accurate for this reason.

Test No. 10 was made through 525 feet of pipe, the flat-top ones being buoyed up by other pontoons.

Owing to increased depth of water, the speed of the winding engines could not be increased to get more sand, and the unbuoyed pipes did not show as much load as in test No. 2.

I think tests No. 2 and No. 10 may be taken as an average through 525 feet of floating pipe, which gives an average of 1,557 cubic yards per hour.

Tests No. 3 and No. 5 may be taken as an average through 1,057 feet of floating pipe under field conditions, the average being 878 cubic yards per hour.

Tests No. 7 and No. 9 may be considered capacity while pumping through 1,057 feet of pipe, the flat-top ones being buoyed up by other pontoons. This average is 1,042 cubic yards per hour.

Plate 93 herewith shows the indicator cards for each test. On test No. 2 only one end of the low-pressure card was obtained, as the signal from the test barge was misunderstood and the engineer shut down the engine.

Respectfully submitted.

C. W. Sturtevant,
Assistant Engineer.

Capt. H. E. Waterman,
Corps of Engineers, U. S. A.

Plate No. 92.—*Record of capacity tests of United States dredge Alpha.*

Number of test.	Date.		Hour.	Duration of test.	Conditions.[a]			Forward movement of dredge per minute.	Main engine.					Main pump.			
					Length of discharge pipe from stern of dredge to valve in measuring barge.	Depth of suction.	Depth of water.		Boiler pressure, pounds per square inch.	Revolutions per minute.	I. H. P.			Head.—Feet of water.			
											High pressure.	Low pressure.	Total.	Suction.	Delivery.	Velocity.	Total.
	1898.			*Secs.*	*Feet.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*								
1	June	1	12.55 noon	69.5	525	12	....	....	160	156	217.3	250.0	467.3	9.6	25.8	3.1	38.5
2		1	2.15 p. m.	95	525	12	6.9	6.9	165	152	217.3	236.0	453.3	13.6	30.4	3.0	47.0
3		2	12.02 noon	93.5	1,057	12	7.5	2.2	165	159	186.1	151.6	337.7	7.4	35.0	1.4	43.8
4		2	3.55 p. m.	101.5	1,057	12	5.7	2.9	125	148	170.6	187.0	357.6	10.2	35.0	1.2	46.4
5		3	9.15 a. m.	101.5	1,057	10	6.2	6.5	156	155	198.0	199.2	397.2	10.2	32.7	2.0	44.9
6		3	11.45 a. m.	102	1,057	12	....	....	155	155	207.5	217.3	424.8	7.4	24.6	2.4	34.4
7		3	1.11 p. m.	101.5	1,057	12	5.6	5.4	160	157	183.1	178.7	361.8	10.2	53.4	0.8	64.4
8		3	3.45 p. m.	120	1,057	12	4.6	3.5	158	162	164.0	165.9	329.9	9.1	38.5	0.2	47.8
9		4	8.22 a. m.	109	1,057	10	5.3	6.3	155	152	196.2	194.4	390.6	9.1	[b]28.1	1.5	38.7
10		4	2.20 p. m.	63	525	12	6.7	6.8	160	152	213.1	262.8	475.9	14.2	30.4	3.1	47.7

[a] Suction pipe 30 inches diameter; discharge pipe 30 inches diameter. Distance from pump to end of suction 66 feet; from pump to stern of dredge 74 feet.

Plate No. 92.—*Record of capacity tests of United States dredge Alpha*—Continued.

Number of test.	Date.		Hour.	Jet pump.		Measuring barge. (Area of water = 2558.7 square feet; area of sand = 2532.5 square feet.)							
				Revolutions per minute.	Delivery, feet of water—head.	Mean depth of material pumped.	Quantity of material pumped.	Quantity of material per second.	Velocity of discharge per second.	Mean depth of sand.	Quantity of sand.	Percentage of sand.	Sand pumped per hour.
	1898.					*Feet.*	*Cu. feet.*	*Cu. feet.*	*Feet.*	*Feet.*	*Cu. feet.*		*Cu. yds.*
1	June	1	12.55 noon	......	......	1.90	4,861.53	69.95	14.2	......	......	......	......
2		1	2.15 p.m.	235	20.7	2.53	6,473.51	68.14	13.9	0.454	1,149.8	18	1,614
3		2	12.02 noon	230	20.0	1.73	4,426.55	47.34	9.6	0.244	617.9	14	881
4		2	3.55 p.m.	228	19.8	1.68	4,298.62	42.35	8.6	0.0731	185.1	4	243
5		3	9.15 a.m.	228	19.8	2.23	5,705.90	56.22	11.4	0.2632	666.5	12	876
6		3	11.45 a.m.	......	......	2.42	6,192.05	60.71	12.4	......	......	......	......
7		3	1.11 p.m.	228	19.7	1.42	3,633.35	35.80	7.2	0.3531	894.2	25	1,175
8		3	3.45 p.m.	230	20.0	0.90	2,302.83	19.19	3.9	0.1883	476.9	21	530
9		4	8.22 a.m.	233	20.5	2.03	5,194.16	47.65	9.7	0.2931	742.3	14	908
10		4	2.20 p.m.	233	20.5	1.70	4,349.79	69.04	14.1	0.2800	709.1	16	1,501

Number of test.	Date.		Hour.	Efficiency.				Weight of a cubic foot of dry sand.	Percentage of voids.	Kind of material.	Remarks.
				Work done per second, measured by material pumped into measuring barge.	Work done per second, measured by indicator cards.	Efficiency, per centum.	Sand pumped per hour, per I. H. P.				
	1898.			*Foot-lbs.*	*Foot-lbs.*		*C. yds.*	*Cu. ft.*			
1	June	1	12.55 noon	168317	257015	65	......	......	......	......	Water test.
2		1	2.15 p.m.	200161	249315	80	3.56	104	30	Medium fine sand.	
3		2	12.02 noon	129593	185735	70	2.61	102	34		
4		2	3.55 p.m.	122815	196680	62	0.68	96	37	Fine sand.	
5		3	9.15 a.m.	157767	218460	72	2.21	97	35	Medium fine sand.	
6		3	11.45 a.m.	180526	233640	56	......	......	......	......	Do.
7		3	1.11 p.m.	144095	198990	72	3.25	100	35	Medium fine sand.	Flat pipes buoyed up with Zeta's pontoons.
8		3	3.45 p.m.	57330	192445	80	1.61	97	36		
9		4	8.22 a.m.	a115258	214831	b54	2.32	96	36		
10		4	2.20 p.m.	205825	261745	79	3.15	99	35		

a Delivery head observed 12 minutes before test; see accompanying report for additional notes.

APPENDIX 2.

REPORT OF CAPT. MASON M. PATRICK, CORPS OF ENGINEERS, UPON OPERATIONS IN THE FIRST AND SECOND DISTRICTS.

United States Engineer Office,
Memphis, Tenn., May 31, 1898.

Colonel: I have the honor to submit the following report of operations in the first and second districts for the year ending April 30, 1898.

FIRST DISTRICT (CAIRO TO FOOT OF ISLAND NO. 40, 220 MILES).

Columbus, Ky. (*21 miles below Cairo*).—In 1889 and 1890 five spur dikes of brush and stone were built along a caving bank in front of this place; these protected 2,200 linear feet of bank. This work at present is in fair condition and has accomplished the object for which designed. Some caving has occurred in recent years between the dikes where the bank was unprotected. No additional work is required at present.

Hickman, Ky. (*26 miles below Cairo*).—In 1889 a mattress of brush and stone 930 feet long was placed along the bank in front of this town. This was repaired at various times and the work extended downstream 630 feet, making the total length of revetment now in place 1,560 feet. No further work is required at present.

New Madrid, Mo. (71 miles below Cairo).—The bank here had been rapidly caving for many years. In 1893 the bank along the upper portion of the town was protected by 900 feet of fascine mattress 250 feet wide, and the upper bank paved. Seven hundred linear feet of similar work was placed below this in 1894.

No money was available and nothing was done during the year. The revetment in place is not sufficient to hold the entire length of this caving bank. An additional extension should be made of at least 1,200 feet.

Plum Point Reach (147 to 186 miles below Cairo).—The works of improvement in this reach have extended from Daniels Point to Craighead Point, Arkansas, a distance of about 20 miles. The operations have been fully described in previous reports. In general terms, the work done has been the protection of caving banks by the construction of 67,400 linear feet of revetment now in place, the closure of Gold Dust Chute by means of pile dikes and a brush and stone dam, and the closure of Osceola and Bullerton chutes by means of pile dikes. The result of these works has been to give an increase in depth over the crossings in Plum Point Reach during extreme low-water stages.

No money was available and no work was done during the year.

CONDITION OF WORKS.

The different works along Plum Point Reach appear to be holding fairly well, but there are a number of places where slight failures have occurred, and the unrevetted portion of the bank has caved badly during the past two years.

At Daniels Point there are three breaks in the revetment, aggregating about 1,300 feet in length, the width of the caving varying from 25 feet to 200 feet.

In Ashport Bend there are three or four places where the work has been injured. Two of these were due to breaks in the old levee and consequent scour; one is due to a settling of the inshore edge of the mats, one to a caving where no paving was ever placed.

There is one small break in the Fletcher's bend work and one near the head of Osceola Bar. This latter place is strongly attacked by the current at high water. There are quite a number of places where there are signs of weakness just about the low-water line.

CAVING OF UNPROTECTED BANKS.

Caving has been active wherever the bank has not been protected. Along the head of Fletcher's bend the bank has caved for a length of 12,000 feet, with an average width of caving of 300 feet. This has destroyed some 620 feet of the upper part of the Fletcher's bend revetment.

Along Upper Osceola Bar, just below New Haven, the caving has extended downstream for 3,000 feet, with an average width of 50 feet. Above the head of the 1895 work the bank has caved for a length of 7,000 feet, an average width of 400 feet and a maximum width of 630 feet. Along the middle of Lower Osceola Bar the bank has caved for some 4,000 feet, with a width of about 60 feet. Below Bullerton Bar to Craighead Landing the bank has caved for a length of 16,000 feet and a width of about 200 feet.

There has been some settling of the Gold Dust dam.

All this damage and caving has taken place since November, 1896.

I recommend that some consideration be given now to the future policy to be pursued in this vicinity. The damage already done to the work is comparatively slight. It can be repaired at little cost, if undertaken at once. Every year that it is neglected the damaged area will increase; its ultimate repair will be more difficult and more expensive. The most critical point along the line is probably in Fletcher's bend, where the caving of the unprotected bank threatens to work its way downstream and destroy all the extensive work now below it. This can probably be prevented by holding some 5,000 feet of the bank just above the present downstream end of the caving. It is not believed that the continued caving of other unprotected banks will work any immediate serious injury to works in place or to navigation. Some work should be done from Daniels Point down to the end of Bullerton Bar at the numerous places where minor damage has been done, or where there are signs of weakness and failure.

LEVEES.

Lower St. Francis levee district (80 to 298 miles below Cairo).—The area which will be protected by the levees when completed will be 3,490 square miles.

The length of this district by river is 218 miles.

Former reports have given the length by the levee line as about 224 miles. Revised locations and other recent changes will probably reduce this length to about 215 miles. In the last Annual Report the length of the levee line then built was given as 115 miles. An accurate survey was made of this line in May and June, 1897. In closing the many breaks in the low, weak levee around Craighead Point, a new line was run across the point. This shortened the levee line about 5 miles. The length from the origin of the line, about 1 mile above Point Pleasant, Mo. (80 R.), to last year's terminus at Pecan Point (195 R.), is now 105 miles. Below Pecan Point the St. Francis levee board during the year constructed 17½ miles of levees, so that the total length of the continuous line is now 122½ miles. Near Walnut Bend (275 R.) there is a levee line 6 miles long, which will form part of the proposed continuous line to the mouth of the St. Francis River (298 R). Including this Walnut Bend line, 128½ miles of levee are now in place, leaving to be constructed for the complete closing of this basin about 86½ miles.

The last annual report was submitted just after the flood of 1897. That report showed that there were some thirteen breaks in the levee line, and that practically the entire basin had been flooded by the phenomenal high water of last year.

In addition to the breaks above mentioned, there were six places where failure had occurred in the Walnut Bend levee.

At the date of the last Annual Report there was one contract in force; this with J. H. Cary for the enlargement of the levee from about 169½ R. southward, at 15 cents per cubic yard. This contract was satisfactorily completed on July 20, 1897.

From the money made available by the sundry civil bill of June 4, 1897, the sum of $63,550 was allotted to levee work in this district. From the same act the sum of $30,000 was subsequently allotted for the repair and enlargement of the Walnut Bend levee.

The general deficiency bill of July 19, 1897, made available $8,437.50 previously allotted and pledged for the work done by J. H. Cary under his above-mentioned contract.

The available money was used in closing the breaks in the line, and in doing some little repair and enlargement at especially weak places along the line.

The work done between May 1, 1897, and April 30, 1898, including the Walnut Bend work, was as follows:

	Cubic yards.
By the United States	615, 686
By the local levee board	566, 156
Total	1, 181, 842

The United States expended in this district for levee construction between May 1, 1897, and April 30, 1898, the sum of $87,514.93. This includes office expenses, superintendence, engineering expenses, and contingencies. The average cost per cubic yard of the work done, including the above items, was 14.21 cents.

For high-water protection the expense incurred by the United States between these same dates was $2,652.37.

The following is a summary of the levees in this district:

	Cubic yards.
Constructed by the United States to April 30, 1897	2, 852, 124
Added from May 1, 1897, to April 30, 1898	615, 686
Total	3, 467, 810
Less losses due to crevasses, levee abandoned by construction of new lines, etc	453, 000
In place April 30, 1898	3, 014, 810
Constructed by levee boards and citizens to April 30, 1897	3, 575, 124
Added May 1, 1897, to April 30, 1898	566, 156
Total	4, 141, 280
Less losses due to crevesses, levees abandoned by construction on new lines, etc	116, 666
In place April 30, 1898	4, 024, 614
Aggregate:	
Erected by United States	3, 014, 810
Erected by others	4, 024, 614
Total effective in place April 30, 1898	7, 039, 424

The high water of this year developed many weak places along the line and did some damage to the levee at exposed points. Considerable work was required to prevent failure. Unless this damage is repaired and the weak places strengthened, it is doubtful whether the line can be held during the next high water. To do this absolutely necessary work will require the putting in place of about 150,000 cubic yards of earth. This work is of the first importance and is strongly recommended.

Caving along the river front of the town of Point Pleasant, Mo. (80 R), destroyed about 900 linear feet of the levee, which was here built close to the edge of the bank and protected the town from overflow. Money was available to close the gap thus made and a proper line for the new levee was located. The local levee board made some effort to obtain the needed right of way, but without success. The work was therefore not undertaken. The citizens seemed to take but little interest in the proposed work, and during the high water of the year it is reported that they made no effort to effect even a temporary closure of the gap. A small levee thrown across Jordans Bayou, joined to the main line and to a high ridge running back of the town, will probably prevent any overflow into the St. Francis basin. It is recommended that this plan be followed.

Although the flood of 1897 demonstrated plainly that the established grades in this levee district were too low, the amount of money available during the past year was not sufficient to permit the necessary enlargement of the levees to be undertaken.

In closing the crevasses in this line, the new levees were built to the grades established prior to 1897. These grades, based upon the high water of 1882, are given in detail in the Annual Report for 1897, p. 3699.

To enlarge the existing levees and raise them to a uniform grade of 4 feet above the 1898 water, with a topping of 50 cubic yards per station, will require the putting in place of about 4,000,000 cubic yards of earth.

No accurate surveys have been made for the location of the portion of the line not yet under construction, but it is roughly estimated that this will require about 11,000,000 cubic yards, in addition to the above.

SECOND DISTRICT (FOOT OF ISLAND NO. 40 TO MOUTH OF WHITE RIVER, 180 MILES).

Hopefield Bend (227–230 miles below Cairo).—The revetment in this bend, now about 16,000 feet long, extends from Mound City Landing to Hopefield Point; it was begun in 1882 and completed in 1888. From 1890 to 1893 extensive repairs were made along the lower 10,000 feet by placing wider river mats and revetting the upper bank with stone. The work along this lower 10,000 feet was failing on account of its narrow width and generally weak design.

Some damage was done to this revetment by the high water of 1897. In general this consisted of scour above and behind the bank paving; in one place the subaqueous work had been swept away. The maintenance of this work is of vital importance to the harbor of Memphis.

For the necessary repairs in Hopefield Bend the sum of $20,000 was allotted from the money made available by the sundry civil bill of June 4, 1897.

The repairs were undertaken in November and completed in December, 1897. The approved project provided for placing a fascine mattress along the portion of the work where the subaqueous revetment had been carried away and the building of crib dikes founded on foot mats across the pockets excavated by the flood waters.

A recent examination shows that the work is all intact and that the cribs are fulfilling their purpose by causing considerable deposits of material in these depressions. (For further details see report of Assistant Engineer Aug. J. Nolty).

Memphis Harbor (230 miles below Cairo).—The bank for a length of 10,166 linear feet has been revetted by the United States, and for 2,206 linear feet by a system of dikes built by the United States employees from funds supplied by the citizens. Most of the work placed has held without loss. Along the upper portion of the harbor front, extending from Wolf River to below Monroe street, a large sand bar has formed. This has made the compress, elevator, and oil mills situated above the paved levee inaccessible to steamboats, and the tailing down of the sand bar along the paved steamboat landing has shut off about one-half of it, or 1,500 feet, to steamboat use during low stages of the river. At the date of the last annual report there remained an unprotected portion of the bank 1,200 feet long between the lower end of the Government revetment and the bridge company's revetment. This gap should be closed as soon as possible. There has been some recent caving of the high bluff along this stretch.

No funds were provided for this work during the year and nothing but minor repairs were undertaken.

The high water of 1897 did some damage to the citizens' dikes; intermediate dike No. 2½ was practically destroyed and the shore paving near the ends of several of the other dikes was washed away. Considerable scour had taken place and the high bank was being undermined.

The project approved November 10, 1897, provided for repairing this damage by rebuilding the injured dike and restoring the paving where it had been displaced. The work was finished in December, 1897; the dangerous scour has been checked and no further failure has occurred. (For further details see report of Assistant Engineer Aug. J. Nolty.)

Wolf River (230 miles below Cairo).—The width of the bar in front of Wolf River at low stages is about 2,100 feet; through this the river has formed a fairly fixed channel to its junction with the Mississippi.

The river and harbor act of June 3, 1896, made available for the improvement of this stream the sum of $35,000. The approved project provided for dredging and the removal of sunken logs, snags, and other obstructions. This work was duly advertised; proposals were opened on July 15, 1897, and award was made to William A. Kirk, the lowest bidder, at 12 cents per cubic yard for material, measured in scows. The contract with Mr. Kirk was approved by the Chief of Engineers August 6, 1897. Work was commenced on September 16, 1897, and prosecuted as vigorously as possible, but under many difficulties, until November 22, 1897. During this period the contractor removed 29,638 cubic yards of material and some few obstructions. The small width of the waterway at low stages, the many interruptions from passing boats, log rafts, etc., seriously hindered the progress of the work. As no work of this character had previously been done at any great distance above the mouth of the river, the actual difficulties of its prosecution had not been fully developed.

On February 7, 1898, the contractor wrote to the president of the commission, stating the obstacles he had encountered and asking to have his contract terminated. This letter was referred to me with instructions to render a report. The required report was submitted on March 8, 1898. The Chief of Engineers directed the preparation of supplemental articles of agreement to close Mr. Kirk's contract. These articles were prepared, and were approved May 5, 1898.

There is still available for this work about $30,000. At an early date authority will be asked to purchase the necessary plant for doing this dredging. It is believed that the much-needed relief can be obtained most effectively and most economically by a plant owned and operated by the United States.

Nonconnah Rock (236 miles below Cairo).—This obstruction, consisting of a ferruginous sandstone and cemented gravel, is about 4 miles below the Memphis bridge and about 700 feet from the Tennessee shore. It has been a source of annoyance to boats with heavy tows, owing to its location directly in the channel.

The removal of this rock was begun in 1893 under contract. Later the work was undertaken by the United States with a plant constructed for the purpose. Very effective work was done and 2,333 cubic yards were removed at the small cost of $1.88 per cubic yard. To complete the improvement as provided in the original project and to increase the depth over the rock to 8 feet below the zero stage on the Memphis gage will require the removal of about 1,500 cubic yards of the rock. This can be done for about $3,000. All the appliances for doing the work are on hand, but, as there was no money available, no work was done during the year. This is an important work; the cost of completing it is small. It is recommended that it be finished at an early date.

Helena Harbor (306 miles below Cairo).—Six hundred linear feet of continuous revetment and 5 spur dikes were built in 1889, protecting about 3,000 feet of bank along the city front. The two lower dikes being in an unfinished condition, the bank caved badly in their immediate vicinity.

As described in the last annual report, some additional work was done with money provided by the river and harbor act of 1896.

The revetment now in place covers a length of 4,110 feet of caving bank. This revetment should be extended downstream for at least 1,000 feet. A recent examination showed that the existing work has been more or less damaged in many places, and considerable repairs are urgently needed to prevent serious failure. The small amount of money available rendered it impossible to do any work during the year.

LEVEES.

White River Levee district (306 to 385 miles below Cairo).—The length of this district by river is 79 miles and by the levee line 64.4 miles. The territory to be protected is a narrow strip of from 8 to 30 miles in width, lying between the Mississippi and White rivers, and having an area of about 910 square miles.

At the date of the last annual report there were 14 crevasses in this line, made during the flood of 1897, aggregating about 17,000 linear feet of levee, and involving a loss of about 350,000 cubic yards. The entire area protected by the levee line had been flooded.

There was one incomplete contract; this with P. McCadden for enlargement, 326–328 R. Work had been interrupted by high water. It was resumed in June, 1897, and satisfactorily completed August 3, 1897.

From the money made available by the sundry civil bill of June 4, 1897, the sum of $128,300 was allotted for levee work in this district.

This sum was insufficient to close all the existing crevasses. After careful study it was recommended to close the breaks near the extremities of the line and to leave open for the present those near the middle. This recommendation was approved, and the work was undertaken on this basis.

The work was duly advertised. Contracts made with the lowest bidders in each case were approved in October, 1897.

There were eight different contracts, and all but one were satisfactorily completed before April 30, 1898. The unfinished contract is with The J. S. McTighe Banking, Construction and Internal Improvement Company, for work at Schoolhouse Bayou. It was intended to have this crevasse closed before the high water of this year, but circumstances made this impossible. The time for its completion has been extended until September 1, 1898.

The work done between May 1, 1897, and April 30, 1898, was as follows:

	Cubic yards.
By the United States	756,656
By local levee boards and others	11,800
Total	768,456

The United States expended in this district for levee construction between May 1, 1897, and April 30, 1898, the sum of $114,600.26. This includes office expenses, superintendence, engineering expenses, and contingencies. The average cost per cubic yard of the work done, including the above items, was 15.15 cents.

For high-water protection the expense incurred by the United States between these same dates was $5,492.80.

The following is a summary of the levees in this district:

	Cubic yards.
Constructed by the United States to May 1, 1897	5,225,958
Lost by crevasses, caving banks, abandoned by building on new lines, etc	645,136
	4,580,822
Added by United States May 1, 1897, to April 30, 1898	756,656
Total in place April 30, 1898	5,337,478
Constructed by levee boards to May 1, 1897	1,007,086
Lost by crevasses, caving banks, etc. (no record).	
Added by levee boards May 1, 1897, to April 30, 1898	11,800
Total in place April 30	1,018,886
Effective levees in place in this district April 30, 1898:	
Erected by United States	5,337,478
Erected by levee boards and others	1,018,886
Total	6,356,364

The grades adopted prior to the 1897 high water are given in the last Annual Report, page 3704. When the levee line was built there was no very reliable information upon which to base a correct grade line. Flood heights were taken from local high-water marks—mud marks on trees and buildings. No contained flood of any magnitude has passed along the completed line, but it is now certain that the adopted grade lines are too low, and that the dimensions of the levees must be much increased in order to successfully restrain the maximum probable flood.

A survey is about to be made to determine the amount of work necessary. It is roughly estimated that the entire line must be raised to a grade of at least 4 feet above the 1897 high water, with a topping of 50 cubic yards per station, and banquettes must be placed wherever the levee is 12 feet or more in height.

To do this, and to close the existing breaks, will require the placing of not less than 6,000,000 cubic yards.

The recent high water developed many weak places along the line. Unless some work is done to strengthen the levee at these points, it is very doubtful whether disaster can be averted during the next high water. To properly reinforce the weak places will require about 500,000 cubic yards of earth. This work is important, and is strongly recommended.

Upper Yazoo Levee district (244 to 365 miles below Cairo).—The length of this district by river is 121 miles, and the length of levee lines 123.88 miles. The territory protected by the levees is 3,281 square miles.

When the last annual report was submitted there was one crevasse (Flower Lake, 300 L) in this line made by the high water of 1897, and the information then gathered tended to show that previously adopted grades were too low to stand a flood of the magnitude of the one just passed. Subsequent study of the data confirmed this opinion. It was made evident that practically the entire levee line must be raised, enlarged, and strengthened.

The grades previously adopted are given in detail in the last Annual Report, p. 3702. The provisional grade adopted for the work done by the United States during the past year was 2 feet above the high water of 1897. On the crown of the enlarged levee was placed a topping of 50 cubic yards per station, raising it about 2 feet more. This brings the levee to a rather sharp crest, but as a temporary expedient it is well worth what it costs. Indeed, there is reason to believe that it might be well to so finish off the crown of all levees, even when they are raised to the selected grade. It provides in advance earth which may be needed in possible emergencies, and at a much less expense than would be incurred in obtaining it during a high-water fight.

The local levee board is well equipped for doing effective work. During the year this body did much toward putting the line in a proper condition. The levee board closed the Flower Lake crevasse.

From the money made available by the sundry civil bill of June 4, 1897, the sum of $73,000 was allotted to levee work in this district. With this money, and the small balance on hand, the United States undertook the enlargement and repair of the S. ½ sec. 76, secs. 77, 78, 79, and the N. ½ sec. 80. The work was duly advertised. Contracts were made with E. B. Mantle for the work on section 76, and with Reese Thomas for work on sections 77, 78, and 79. These contracts were approved October 4, 1897. Upon my recommendation the Secretary of War authorized an open-market agreement with Martin Jennings & Co. for the work on section 80.

The work on section 76 was satisfactorily completed on April 1; on section 80, April 15, 1898. The remaining work is still in progress and will probably not be finished before July, 1898.

	Cubic yards.
There was constructed by the United States from May 1, 1897, to April 30, 1898	288,702
And by the local levee board during the same period:	
Embankment	2,262,297
Muck ditch excavation, etc	204,922
Total work done	2,755,921

The United States expended in this district for levee construction between May 1, 1897, and April 30, 1898, the sum of $50,497.63. This includes office expenses, superintendence, engineering expenses, and contingencies. The average cost per cubic yard of the work done, including the above items, was 17.49 cents.

For high-water protection, the expense incurred by the United States between these same dates was $3,953.68.

The following is a summary of the levees in this district:

	Cubic yards.
Constructed by the United States to May 1, 1897	4,351,669
Lost by caving banks, crevasses, abandoned, etc	225,110
In place May 1, 1897	4,126,559
Added by United States from May 1, 1897, to April 30, 1898	288,702
Total in place April 30, 1898	4,415,261
Constructed by levee board to May 1, 1897	8,585,556
Lost by caving banks, crevasses, abandoned, etc. (estimated)	785,870
	7,799,686
Added by levee board May 1, 1897, to April 30, 1898, including muck ditch and excavation work	2,467,219
Total in place April 30, 1898	10,266,905
Levees in place April 30, 1898:	
Erected by United States	4,415,261
Erected by local levee board	10,266,905
Total in place	14,682,166

The estimated yardage required to raise and enlarge this levee line to the grades indicated as necessary by the high water of 1897 is approximately 18,000,000 cubic yards.

GENERAL REMARKS ON LEVEE WORK IN ALL THREE LEVEE DISTRICTS.

All levee work was pushed as vigorously as possible, but it was carried on under many adverse conditions. During September, October, and November, on account of the presence of yellow fever at several points in the Mississippi Valley, many localities along the river established rigid quarantine regulations. The contractors who had not moved on their work were prevented from doing so; those who had made a beginning were hampered in their efforts to obtain the needed supplies, material, and labor. Quarantine restrictions were generally removed in the latter part of November. During December and January the weather was most unfavorable for levee work; much time was lost on account of rain. This heavy rainfall, rather unusual at such a time of the year, caused the river to rise rapidly in January; the borrow pits were filled with water, and all work interrupted. Much emergency work had to be done at considerable expense. Fortunately the river came to a stand just short of the point beyond which great damage might have been done.

This rise further delayed the completion of the work.

A period of good working weather followed, and all of the most important work was finished before the highest water of the year came against the levees.

SURVEYS, GAUGES, AND OBSERVATIONS.

In June and September, 1897, surveys were made of Memphis Reach and Harbor, including Hopefield Bend. These surveys show that but little change has taken place in this vicinity during the last two years. The bar in front of the upper part of Memphis Harbor and of the steamboat landing has increased in height, but has not moved downstream. As long as the shore line in Hopefield Bend can be held in its present position it seems reasonable to believe that no substantial change will take place along the water front of Memphis.

In January, 1898, a survey was made of Plum Point Reach to determine the changes during the year and the condition of the works. The information thus acquired is detailed in this report under its proper head.

In May, June, and July, 1897, a survey was made of the entire St. Francis levee line, including the levee at Walnut Bend. Permanent mile posts have been established along the line, and much useful information was collected.

In November, 1897, a small survey was made near Point Pleasant, Mo. (80 R), to determine the damage to the levee by the caving of the river bank, and to locate a new line to close the gap thus made.

Other small surveys were made during the year as work progressed at various places. All field work was plotted, and all observations were carefully worked up.

STAGES OF THE RIVER DURING THE YEAR, AND VARIOUS GAUGE RECORDS IN THE FIRST AND SECOND DISTRICTS.

The last annual report was written before the great flood of 1897 had entirely subsided. During the remainder of the calendar year river conditions were about normal.

There was a good stage of water during the summer months. September, October, and November were very dry; the river fell rapidly. The lowest stage was reached at Cairo on October 21, when the gauge read +2.5 feet, which was 3.5 feet above the lowest recorded reading; at Memphis on October 28, when the gauge read +0.2 foot, which was 2.85 feet above the lowest recorded reading, and at Helena on October 29, when the gauge read —0.8 foot, which was 2.2 feet above the lowest recorded reading.

The heavy rains of December and January caused the river to rise rapidly; this rise bore considerable resemblance in its magnitude and in the time of its arrival to the January rise of 1891. The river reached just a little above a bank-full stage before it came to a stand. Some little protection work was done in the different levee districts at places where complete closure of existing breaks had not been effected. No considerable damage was done, but the borrow pits were filled with rain, river, and seep water; all work was thereby delayed. Active operations were resumed as early as possible; all crevasses but one (Schoolhouse Bayou, White River district) were securely closed before the coming of the highest water of this year. Heavy rains throughout the valley of the Ohio River in March swelled that stream to flood proportions. On March 29 the Cincinnati gauge read 61.4 feet, which was 0.3 foot higher than the maximum reading in 1897. The crest of this rise reached Cairo on April 6, with a gauge reading of 49.8 feet, which was 1.9 feet less than the highest reading in 1897, and 2.37 feet less than the maximum recorded reading, 1883.

The flood of this year is not comparable with that of 1897, except as to the heights attained. At nearly every observed point in these districts below Cairo this year the height reached was greater than ever before known except in 1897. This year the Cairo gauge remained above 40 feet for twenty-five days, as compared with sixty days in 1897.

LOWER ST. FRANCIS LEVEE DISTRICT.

As soon as it was evident that the levees would be seriously strained, men and materials were sent to selected points along the levee line. The United States employees took entire charge of a portion of the line, while the local levee board cared for the remainder. Considerable work of the usual character was done; the line was held intact. This was the first contained flood of any magnitude to pass along this front. Careful record was made of the greatest heights obtained at many points; the data secured will be valuable in the future determination of levee grades. The numerous breaks along this line in 1897 made the record of the high water of that year very imperfect.

As the maximum gauge reading at Cairo this year was 1.9 feet less than in 1897, it seems reasonable to believe that with no breaks in the levee line the water surface last year would have been about 2 feet higher at all points than the heights reached in 1898.

The water of this year is really the best available guide to the solution of the problem of proper grades for these levees. It is probably a safe assumption that the St. Francis levees must be raised and enlarged to a grade line at least 4 feet above the high water of this year.

To this report is attached a profile showing the high-water line of this year, that actually observed in 1897, and this latter line as it might have been if no breaks had occurred in the levees.

WHITE RIVER LEVEE DISTRICT.

The many breaks in this line during 1897 rendered the observed heights attained by the flood of that year of comparative little value except as a general demonstration of the fact that the adopted grade lines were much too low. It did not afford any reliable basis for the fixing of future levee grades. As previously stated, it was necessary this year, on account of lack of funds, to leave open the breaks near the middle of the line. A considerable volume of water escaped through these openings; this of course modified the high-water line of this year. Some little information was gained as to the effect of these breaks. At Helena the maximum gauge reading in 1898 was 49.2 feet, which was 2.6 feet less than the actually observed maximum in 1897, and probably 4.0 feet less than the height which would have been reached last year if no crevasses had occurred in this vicinity. There is still no exact information upon which to establish proper grades for these levees; it seems reasonably certain that in the upper part of the district they must be raised to at least 6 feet above the high water of this year. To close the existing breaks to the present grade will be to invite disaster. The possible damage which can be done by the water which passes through these openings is slight. It is recommended that no effort be made to close them until the rest of the line is enlarged and much strengthened.

UPPER YAZOO LEVEE DISTRICT.

The Flower Lake (300 L) break last year and the many crevasses on the opposite side of the river modified the high-water readings of 1897. During the passing of the flood of this year the Flower Lake break was closed, but the opening still existing in the White River line exercised a marked influence on the height attained along the Yazoo levees. It is certain that with continuous lines of levees on both sides of the river in this vicinity the Yazoo levees must be raised and enlarged in order to successfully withstand a flood like that of 1897.

GAUGE READINGS AT MEMPHIS.

There is considerable confusion in the existing records of the high-water reading here in 1897. The United States weather observer gives it as 37.1 feet; Captain Fitch in his annual report gives it as 37.8; elsewhere in the last annual report of the Commission it is given as 37.7; the official gauge reports published by the Secretary of the Commission give it as 37.6; the records of this office give it as 37.68. It is stated that before the river ceased rising the gauge at the foot of Beale street was washed away; subsequent readings were taken on a gauge near the foot of Jefferson street. The Weather Bureau observer states that he had previously noted a difference of 0.6 foot between the readings of these two gauges, and he accordingly diminished the maximum observed reading on the Jefferson street gauge by this amount. It must be remembered that the Jefferson street gauge is so located that the filling and emptying of an eddy influences its reading.

Before the high water of this year the Beale street gauge had been carefully reestablished. The maximum reading on this gauge this year was 37.22 feet. Careful observations were taken this year at the highest stage of the difference of reading between the two gauges above mentioned, and it was found that the Jefferson street gauge read 0.37 foot above the gauge at Beale street. The maximum reading of the Jefferson street gauge in 1898 was 37.59, or about 0.1 foot less than in 1897.

All gauge readings and local high-water marks indicate that near the upper part of Memphis Harbor the high water of 1898 reached about the same height as in 1897. Just above the bridge the 1898 water was from 0.2 foot higher on the Tennessee side of the river to 0.5 foot higher on the Arkansas side than in 1897.

For the purpose of protecting the approaches to its bridge across the river just below Memphis, the bridge company has built embankments, which have undoubtedly lessened the area of cross section of the available waterway at the bridge site and dammed back the water above the bridge.

PLANT.

Most of the plant which has been accumulated in these districts is now stored near Memphis, the floating property being tied to the bank a short distance below the bridge. This plant consists of steamboats, quarter boats, shop boats, graders, pile drivers, barges of all kinds, miscellaneous craft, machinery, and the necessary outfits for large working parties. There are now borne on my property return some 24,000 articles, the original cost of which was about $450,000.

Most of this plant is in fair condition. To keep it fit for use repairs must be made from time to time. The care of the plant and the absolutely necessary repairs will require the expenditure of about $25,000 each year.

The only addition of any moment made to the plant during the year was a new steam towboat named *Chisca*, which was built by Ed. J. Howard at Jeffersonville, Ind., under contract approved February 26, 1897. The contract price was $25,900. This boat was delivered at Cairo, Ill., on August 14, 1897. The *Chisca* is 160 feet long, 30 feet wide, engine cylinders 18 inches in diameter, with 7-foot stroke. The machinery and boilers were built by Charles Hegewald Company, at Albany, Ind. The boat is well adapted for the service for which it was designed, and has proved its usefulness. The specifications and drawings for this boat were prepared in this office by Assistant Engineer W. M. Rees.

Repairs were made during the year to many pieces of floating property, the most important being the rebuilding of the hulls of the steamers *H. L. Abbot* and *H. M. Graham*. This work was done by United States employees in the Government dry dock here.

By authority of the Chief of Engineers, September 23, 1897, two barges were transferred to the Marine-Hospital Service for use as a quarantine station.

By authority of the Chief of Engineers, February 25, 1898, the steamer *Titan* and twelve barges were temporarily transferred to the officer in charge of the Third district.

In compliance with orders received April 4 from the Chief of Engineers, the steamer *Chisca* was sent to Shawneetown, Ill., which place had been flooded by the breaking of the levee in front of the town. The boat and crew rendered such assistance as was possible to the local authorities until April 12, and returned to Memphis on April 14.

(For further details see report of Assistant Engineer Aug. J. Nolty, in charge of plant.)

I desire to place on record my appreciation of the fidelity with which the work intrusted to them has been performed by my assistants and by the other employees connected with this office.

Attention is invited to the accompanying report prepared under my direction by Assistant Engineer W. M. Rees on levee construction and seepage through levees.

While I do not indorse all the views advanced, yet I think the report of sufficient interest to warrant its presentation to the Commission.

The following papers and drawings accompany this report:

Report of Assistant Engineer W. M. Rees on levee construction and seepage.

Report of Assistant Engineer Aug. J. Nolty on care and repair of plant, and construction work.

List of civilian engineers.

Map of Plum Point Reach.

Map of Hopefield Bend and Memphis Harbor.

Details of construction work in Hopefield Bend.

Map of First and Second districts, showing existing levee lines and dates of work.

Profile Lower St. Francis Levee line, showing work of the year and high-water lines.

Profile White River Levee line, showing work of the year and high-water lines.

Profile Upper Yazoo Levee line, showing work of the year and high-water lines.
Profile Lower St. Francis Levee line, showing various high-water lines.
Overflow map of the First and Second districts.
Drawings of levee sections accompanying report of Assistant Engineer W. M. Rees.

Very respectfully,

MASON M. PATRICK,
Captain of Engineers, U. S. A.

Col. G. L. GILLESPIE,
President Mississippi River Commission.

Financial statement.

IMPROVING MISSISSIPPI RIVER, FIRST AND SECOND DISTRICTS.

July 1, 1897, balance unexpended	$119,979.96	
June 30, 1898, amounts appropriated and allotted since last statement	379,850.00	
January 15, 1898, amount received from B. F. Dame for rent of island in Mississippi River, near Australia, Miss., for year 1898	1.00	
April 19, 1898, amount received on account of proceeds of Government property	135.45	
		$499,966.41
June 30, 1898, amount expended from July 1, 1897, to date	370,828.69	
April 19, 1898, amount deposited to credit of Treasurer United States on account of proceeds of Government property	135.45	
January 15, 1898, amount deposited to credit of Treasurer United States on account of rent of island in Mississippi River, near Australia, Miss., for year 1898	1.00	
October 11, 1897, amount of Treasury settlement No. 2490	.30	
April 28, 1898, amount of Treasury settlement No. 4766	1.08	
March 19, 1898, amount of Treasury settlement No. 6006	10.00	
		370,976.52
June 30, 1898, balance unexpended		128,989.89
Outstanding liabilities	4,560.20	
Amount covered by uncompleted contracts	61,282.17	
		65,842.37
Balance available		63,147.52
Amount that can be profitably expended during fiscal year ending June 30, 1900		1,000,000.00

Submitted in compliance with requirements of sections 2 of the river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

REPORT OF ASSISTANT ENGINEER W. M. REES ON LEVEE CONSTRUCTION AND SEEPAGE.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., April 30, 1898.

SIR: I have the honor to submit the following report upon the seepage of levees, together with some views as to its amelioration by better construction.

Upon the subject of seepage I find very little information and no reliable experiments. All of our levee engineers have no doubt noticed seeping levees at numerous localities during flood times, and have had to deal with the problem of preventing the land-side toe of the levee from sloughing, due to its very thorough saturation. The means usually employed are to place upon the soft and almost liquid earth layers of brush, and upon the brush sacks of earth to hold it in place, taking care to leave spaces between the sacks to enable the water to drain out. When sloughing has been prevented in this manner, and the discharging water is free from sediment, it is usually considered that the danger of a break has been prevented.

As the impermeability of the material in a levee embankment can not be relied upon, I think it is a rather difficult matter to establish the line of saturation. This might be determined approximately by making experiments with each of the various kinds of material of which our levees are constructed; but in the practice of levee building these materials, which may be classified as loam, sandy loam, sand, sandy clay, and "buckshot" clay, are deposited in the embankment at random, or just as they may come from the borrow pits, hence a determination of the line of saturation for each class would not more than give us the basis for a fair guess as to the location of this line in levees as now constructed.

I think it is the usual practice of engineers familiar with the construction of earthen dams to assume that if the embankment is composed of such material as loam, sand, and sandy clay, that the angle of repose when saturated will be as low as 1 on 6 or even 1 on 8.

If we assume the slope to be 1 on 6, then for a levee having a height of 8 feet, with 8-foot crown, and 1-on-3 slopes on both sides, and with the water 6 feet high against this embankment, the line of saturation will fall 2 feet within the base. Should the line of saturation be flatter, sloughing would probably take place.

I have noticed many levees of the above dimensions, with 6 feet head of water against them, which stood quite well and showed no sign of sloughing, though at places there was water seeping through. These levees, as far as I could tell, were built of fine material.

Again, other levees built with the same crown and slopes, but much higher, would stand well with fully twice the head of water against them, but in these cases their composition was largely of buckshot clay, containing little or no fine sand or silt which would wash out under the pressure produced by the head of water. Buckshot-clay levees will leak badly when new, due to the manner in which the clay is put up, which is usually in lumps with many interstices, but as the clay is quite tenacious, sloughing rarely occurs.

Levees of which medium coarse sand is the large component, are, I think, rather rare. In several places where I have seen them I have observed that the water percolated through them without making the inside toe sloughy. These levees were of moderate size, viz, from 8 to 11 feet in height, and I judged were built of a sandy clay in which the sand was of moderate coarseness. The sand showed up prominently all over the surface of the levee.

If the present manner of construction is to be followed, viz, using the material just as it is taken from the borrow pits, putting it up in layers of 2 to 3 feet thickness, and distributing it at random through these layers, then I would propose the following dimensions of cross section, based upon these assumptions: First, that the line of saturation in ordinary material will assume a slope of about 1 on 6; second, that the crown of the levee is 2 feet above the maximum high water.

The section of the levee is then to be, 8-foot crown, with 1-on-3 slopes on both sides; when the levee exceeds 8 feet in height, banquettes are to be placed on the land side as follows: Banquettes to intersect the land-side slopes of the levee at 8 feet below the crown (or 6 feet below the high-water line), and have crown slopes of 1 on 10, side slopes of 1 on 4, up to a levee height of 20 feet, above which height the side slopes are to be 1 on 5.

For levees having a height of between 8 and 11 feet, banquette crowns to be 10 feet wide; between 11 and 14 feet, banquette crowns to be 20 feet wide; between 14 and 17 feet, banquette crowns to be 30 feet wide; between 17 and 20 feet, banquette crowns to be 40 feet wide. All of the above banquettes to have land-side slopes of 1 on 4. Levees of a height above 20 feet to have banquettes 40 feet wide, with side slopes of 1 on 5. These sections will produce a levee the surface of which will be above the assumed line of saturation, as shown on accompanying drawing No. 1.

Modification of the above might be made, depending upon the material. Thus, if the levee was composed mostly of buckshot clay, the banquette might be started at the plane 12 feet below the crown.

I have made the above suggestions as to levee dimensions upon the supposition that the present plan of construction is to be continued, but I do not concede that this plan is the best or the most economical for permanent structures.

According to present specifications the base upon which the embankment rests, and for 10 feet outside, is thoroughly cleared of trees, stumps, and all vegetable matter; the surface is thoroughly broken to a depth of 6 inches; a muck ditch is dug of such dimensions as are considered sufficient to explore the base for buried logs, etc. This ditch is refilled with selected material and tamped while being filled by teams passing over it, or by men with mauls. The stump holes are also filled in the same manner.

The construction of the levee begins by depositing the earth, which is freed from roots, trash, or objectionable material, in layers of 2 feet in thickness; this is done either with drag or wheel scrapers.

From an examination of numerous levees already constructed, I have observed that the muck ditch is simply an exploration ditch; that it sometimes is cut so deep as to pass through an impervious stratum and have its bottom in sand or silt, and that the filling material—which is generally tamped in dry—may be either a sandy loam, buckshot clay, or a mixture of the same; it certainly is not a water-tight filling.

The embankment may, and generally does, rest upon material not impervious to water, and the layers of which the bank is composed are of such material as the contractor can most conveniently get from the borrow pits. Thus on the surface usually occurs loam, sand, or sandy loam, and these will then constitute the lower layers, while as the pits are dug deeper buckshot clay may be encountered, and this will enter into the top of the embankment. The practice of erecting in layers 2 feet thick results, I think, merely in compressing the upper quarter or even less of each layer, leaving the balance uncompressed. I can not see how this is good practice, as the result is a structure unhomogeneous in character and with a series of horizontal surfaces of cleavage through it. I believe that better construction would be to avoid the layers so that the material in the embankment would be as homogeneous as possible. It would then settle better and make a more compact structure.

I think it may safely be said that along nearly every section of levee line there is considerable good material, such as clay or buckshot, and I believe that if this material were properly distributed in the embankments the result would give us levees which would more successfully resist the floods. I should classify the available materials as to their usefulness to resist water pressure, as follows: Loam being the poorest, then sandy loam, sand, sandy clay, clay, and buckshot, the latter being the best, while a sandy clay may be quite good if the sand is coarse; it may be extremely bad if the sand is quite fine.

As it may be necessary to use several or all of these kinds of material in the construction of a levee, I should endeavor to arrange them so that the best material would be on the river side, with the poorest on the land side, my plan being to keep the water out of the bank, if possible, by placing sufficient good material on the river-side slope, and by quickly getting rid of what little water does pass through this portion.

I therefore submit the following general plan for levee building:

1. *For a new levee.*—Remove all stumps and trash from the base as is now done; break up the surface thoroughly; if the surface is of bad material, i. e., pervious to water, excavate on the river half of the base down to good material, moving the poor material toward the land side of the embankment; cut a muck ditch just on the river side of the center line and of depth sufficient to heel into a fairly impervious stratum, clay or buckshot. Then fill up the muck ditch and stump holes with the best impervious material obtainable, tamping the same with plenty of water; break up roughly the foundation between the muck ditch and the river-side toe; the base is then prepared and the construction of the embankment can proceed. As the least suitable material generally lies near the surface, place this on the land side of the muck ditch, placing a layer of sand on the bottom if any is available, in order to more readily carry off any seep water. Build up from the muck ditch a puddle wall of clay or buckshot, this wall to be 4 feet thick at the crown, and to have a batter on each side of about 2 inches to each foot of height. Place all the best material, such as clays and buckshot, on the river side of the puddle wall and the poorest material on the land side of the puddle wall; in carrying up the work let the land side be 3 or 4 feet higher than the balance of the embankment all the time.

The above method would require about one-half of the material to be of the better class, or fairly impervious soil. This proportion will be found in many localities, but where as much can not be found I would suggest a modification by placing the muck ditch and puddle wall entirely on the river side of the crown. I believe that if the river side one-third of the levee is made of good material, impervious or nearly so, it will make a perfectly safe embankment, for any water which may soak through this would find free egress through the lighter material of the backing.

A drainage ditch should then be placed near to and along the land-side toe of the levee, to quickly get rid of seep water.

The puddle wall which I have suggested will no doubt add considerably to the first cost of construction, but I think it would be economical in the long run. If this is abandoned, I think it would be necessary to put up the river-side filling of buckshot clay in a wet condition, so that it will be fairly well compacted before a flood comes against it. As you are aware, buckshot clay is usually deposited in a lumpy condition, and shrinks considerably before it finally makes a compact levee. Under the present system of placing material, a new levee with the river-side third of buckshot would be quite open when the first flood came against it, and the leakage through it might be so great that the inside backing of pervious material might become too highly charged with water and therefore slough.

The plan of placing a tenacious material on the river side would also greatly reduce the danger of wave wash. This could be still further reduced along very exposed places by making the river-side slope flatter.

It will probably be contended that crayfish and burrowing animals will cut through this clay filling, but these are not a source of much trouble along the levees of the First and Second districts, and even if they did bore through the clay they would cause seepage at but few points in the levee, and the amount so caused, I believe. would readily be carried off through the sandy backing without producing a sloughing condition.

2 *Enlargement of old levees.*—This is the most important work in the First and Second districts, as the greater part of the river front is now leveed, but to grade lines too low to withstand maximum floods, consequently enlargement is required along nearly the entire line. It is difficult to say of what material the existing levees are built, and how it is distributed throughout them; little or no information on this subject has been collected. Something might be learned by a careful examination of the borrow pits along the levees. We may in general assume that existing levees are of a composite nature; some blocks contain a mixture of about all grades of material to be found in the top alluvium, or from loam through sand to buckshot.

At many places these levees are good, showing little or no seepage after long exposure to the water, but at many other places seepage and sloughing are troublesome during floods. In the enlargement of these latter levees I propose that a muck ditch be cut at the toe of the river-side slope down to some fairly impervious stratum, this ditch to be filled with buckshot clay well puddled; on this a puddle wall to be constructed along the river-side face, this wall to be of about the same thickness as the proposed wall for new levees, or say, about 6 feet thick at the crown, increasing in thickness 3 or 4 inches for every foot of depth.

I believe such a wall would keep the old levee fairly dry and be worth much more than banquettes on the land side.

To construct a good puddle wall on the river-side slope of a levee 14 feet high, including muck ditch, would require about 27,000 cubic yards per mile. This could be put up either by wheelbarrows or scrapers, and the cost of putting the material in place would be practically the same as for any other enlargement work made of buckshot clay, making a proper allowance for overhaul beyond the 300-foot limit. Water for tamping can probably be obtained along most of the levees, either from ponds or from the river. Probably the cheapest plan would be to use a portable boiler on wheels with a steam pump of proper size, located at the water-supply station, and force the water through a line of 2½-inch wrought-iron pipe, arranging the same for hose connections at numerous places. A plant of this description for supplying 75 gallons of water per minute at 5,000 feet maximum distance should not cost over $1,600, and should furnish sufficient water to puddle about 1,000 cubic yards per day.

Water might also be obtained from bored wells at a small cost.

If the work of constructing such puddle walls is let in blocks of from 100,000 to 150,000 cubic yards, I believe the cost should not exceed 2½ to 3 cents per cubic yard of embankment for water and 3 cents per cubic yard for the labor of puddling.

I would suggest that, as an experiment, it might be well for the Government to build puddle walls along some of the old levees by hired labor, as this would be a good method of solving the cost problem.

There are no doubt localities where the above-suggested plans are not applicable on account of there being no suitable material within reasonable hauling distance. At such places I would back up the land-side slopes with properly designed banquettes.

I consider it quite important that a careful study be made of the soil strata along our levee lines. Data showing in detail their location, thickness, and classification, would greatly aid in planning future work, and also give a fair idea of the composition of the levees now built. This information might be obtained by an examination of the borrow pits and by a series of shallow borings. Upon the appearance of a flood, seepage observations should be made along the entire line of levees. With such information some scientific knowledge of seepage conditions and slopes of repose of saturated material, etc., may be deduced.

When it is decided to take earth from one side, none should be taken from the opposite side, unless it be just the top soil and down only to the top of the first fairly water-resisting stratum; and even in this case wide berms should be left. The earth for our levees has in general been taken from the river side, leaving only a berm of moderate width. I think this width should be increased so that the distance from the river-side toe of the levee to the berm should be fully 60 feet in light material. As to the depth of borrow pits, I think a deviation from the specifications could be allowed in some localities, for if the bottom of the pit is in good retentive soil, and this has a considerable thickness below the depths now allowed, I see no reason why the contractor should not be allowed to go deeper, always provided that a sufficient thickness of good, retentive material be left to prevent seepage into any pervious stratum below.

As much of the work of the future will be the enlargement of existing levees by the addition of 50,000 cubic yards and upward per mile, it has occurred to me that new methods of placing material may supersede the present method of mules and scrapers. If contracts are let in larger blocks, say about 200,000 cubic yards minimum, the earth might be placed more advantageously and quickly by the use of steam haulage and dump cars.

It is probable that there is another material advantage in this method, in that the material can be obtained at a distance of 1,000 feet or more from the present levees, and with scarcely an appreciable increase in cost; in mule and scraper work each additional 100-feet haul adds largely to the cost.

Accompanying this paper are drawings of the proposed levee sections.

Respectfully submitted.

W. M. REES, *Assistant Engineer.*

First Lieut. MASON M. PATRICK,
Corps of Engineers, U. S. A.

REPORT OF ASSISTANT ENGINEER AUG. J. NOLTY ON CARE OF AND REPAIRS TO PLANT, AND CONSTRUCTION WORK AT HOPEFIELD BEND (ARKANSAS) AND MEMPHIS HARBOR.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., April 30, 1898.

SIR: I have the honor to submit my annual report on the care of and repairs to plant at Memphis, Tenn., of the construction work at Hopefield Bend, Arkansas, and at Memphis Harbor, for the year ending April 30, 1898.

CARE OF AND REPAIRS TO PLANT.

The plant has been properly cared for. This care has necessitated a considerable amount of minor repairs, in addition to those of greater magnitude specifically mentioned below.

Steamer Chisca.—This vessel was received from the builders August 14. Since that time it has been fitted with a steam steering apparatus. As is usually the case with a new vessel, some changes, repairs, and alterations were necessary. These have about all been made, and the performance of the boat is very satisfactory.

Steamer Titan.—A new breeching was made for this boat, one new sheet put into middle boiler, new piston packing put into the starboard cylinder, and that of the other one repaired. In addition, the boat has been calked from the light-load line up, and otherwise repaired. The boat was on March 7 temporarily transferred to the Third district.

Steamer H. M. Graham.—A new hull was built under this boat, new breeching made, engines repaired, new sheet put into starboard boiler, cabin repaired, boat painted, etc. This vessel is now practically as good as new.

Steamer H. L. Abbot.—This boat received practically a new hull and had repairs made to cabin and machinery.

Tug Itasca.—Has been docked for cleaning and painting of hull, and received minor repairs.

Machine shops Nos. 1 and 2.—Shop No. 2, heretofore in continual use, was in such bad condition from old age that either abandonment or extensive repairs became necessary. As shop No. 1 was in much better condition than the other, it was decided to abandon No. 2 and repair No. 1. Such machine tools as were not duplicated on the latter were taken from the former and fitted up on No. 1. The repairs to No. 1 consisted of almost entirely rebuilding the hull.

Barges.—Four mooring, 4 fascine, 2 mattress, and 28 ordinary barges were calked from the light-load line up. Of the ordinary barges 12 were for loan to the Third district, and the cost of repairs to these does not appear on the abstract of expenditures, as the account was paid by that district. The other barges were for use on construction in Hopefield Bend and at Memphis Harbor.

In anticipation of a recurrence of a disastrous flood, the steamers, two quarter boats, and 24 skiffs were put into condition to answer an immediate call.

The steamers *Abbot* and *Itasca* were at various times engaged for short periods on survey duty.

Hydraulic graders Nos. 2, 4, and 40.—Grader No. 40 is in good condition. Both graders No. 2 and 4 were in such condition that constant labor and watchfulness were required to keep them afloat. In view of the limited amount of funds available, and of the curtailment of the amount of revetment work to be done, two graders were deemed ample for any probable requirements. It was therefore decided by the district officer to repair one of the machines and to beach the other one at high water to prevent any possible loss of valuable machinery. No. 2 was selected as the one to be repaired, as it contained the best pumps.

This machine is now on the dock undergoing extensive repairs. The repairs will be equivalent to an entirely new hull. As our floating dock is very much weakened by age, it was deemed best to remove everything from the decks except the boilers, so as to strain the dock as little as possible. Repairs will be well advanced toward completion by the end of the current month.

Included in the item "Tools and appliances" is one band saw, purchased at a cost of $132.85. This machine has proved a most valuable adjunct to the tools of the shop.

The item "Towing" represents the cost of steamers *Abbot* and *Itasca* while in commission as fleet tenders.

On April 4, in compliance with orders received, the steamer *Chisca* proceeded to Shawneetown, Ill., to render assistance to that town, which had been flooded by the breaking of the north levee. The boat returned from the performance of this duty on the 14th of the same month.

At the beginning of the period covered by this report the steamers *Titan* and *Graham* were still engaged in bringing back plant which had been in use at the St. Francis and White River levees. The steamer *Abbot* also made one trip down to Burks, Miss., on the same duty. In addition to the above, the steamers *Chisca* and *Titan* have made various trips of inspection.

As soon as grader No. 2 is ready the entire plant now afloat will be in fairly good condition for remaining laid up for the ensuing year. However, should any construction work be undertaken this year, repairs, mostly calking, will have to be made to the plant to be used.

One quarter boat and one barge have been condemned by proper authority and afterwards sold at public auction, together with a lot of other condemned property.

A severe storm prevailed here on January 25, doing considerable damage to the fleet, mainly in the nature of broken timberheads, fenders, and damaged guards.

A cave in in the high bank near the foot of the fleet damaged one barge so badly that it will hardly pay to repair it.

Cost of, care of, and repairs to plant, May 1, 1897, to April 30, 1898.

Steamer *Chisca*	$2,366.50
Steamer *Titan*	1,000.18
Steamer *H. M. Graham*	5,139.24
Steamer *Itasca*	97.18
Steamer *H. L. Abbot*	1,797.25
Machine boat No. 1	988.56
Machine boat No. 2	125.59
Barges	[a] 897.07
Skiffs	[b] 98.75
Surveys	170.40
Miscellaneous	1,124.56
Floating dock	43.40
Quarter boat *Mississippi*	62.05
Care of plant	13,839.41
Hydraulic grader No. 2	164.20
Tools and appliances	346.81
Towing	1,275.42
Total	29,536.57

Construction, Hopefield Bend.—The flood of 1897 damaged the revetment of this bend at a number of places by excavating deep pockets, the longest dimensions in each case parallel to the direction of current; some of these pockets were scoured out as much as 16 feet below the original grade of the revetment. A preliminary survey made during July showed that there were six of these places along the revetment; one, however, was of small extent and would require only regrading and repaving. All the damage originated at or near the upper limits of the paving. The initial cause of the damage was the denuding of the bank of the riprap. In all cases but one the destructive action had extended more toward the land than the river side, and in only one of these faults (sill No. 6 on sketch) had the subaqueous work been involved. That the first step in the destructive action of the current was the removal of the stone was plainly evidenced by the entire denudation of portions of the bank surrounding the craters, and by the piles of stone found at the lower ends of each.

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[a] This item includes mattress, mooring, fascine, and ordinary barges put into condition for use on construction Hopefield Bend and Memphis Harbor.

[b] Twenty-four skiffs were repaired and calked in anticipation of a high-water fight.

To repair these faults by restoring the original grade and paving would have required the hauling of a large amount of filling material, and it was feared that a subsequent flood might repeat the same destructive action. It was therefore decided to build brush-and-stone sills, founded upon fascine mats, across the pockets, and let subsequent high waters do the filling. These sills would offer a firm barrier against any further action of the current.

The project having been approved, work was begun on August 12 by getting barges for towage of stone and all other plant to be used on construction ready for service.

On September 15 a tow of barges left for Fletchers Bend, at which place a quantity of stone was stored on the bank, and the work of loading this on the barges was at once begun. Three thousand one hundred and sixty-seven cubic yards were loaded and towed to Hopefield Bend between September 18 and October 15. The loading was done by a self-subsisting force at a cost of $0.322 per yard. This very high cost was due altogether to the fact that the flood of 1897 had so completely silted up the stored piles of stone that the latter had to be literally excavated with pick and shovel. The cost of the towage was $0.214 per cubic yard. This work was done by the steamer *Chisca*. All stone was held on barges until the work was ready to receive it.

Plant was sent to Hopefield Bend between October 1 and 4, and actual construction begun on the latter date, when a river mat, 110 feet wide by 280 feet long, to cover the damaged subaqueous work in front of fault No. 6 was begun with a small force. It was completed and sunk on the 13th of the same month. A connecting mat, made necessary by the deep indentation of the shore line, and aggregating 54 squares, was next placed, after which the construction of the floor mats upon which the sills were to rest, and of the various cribs composing the sills, was successively undertaken. Sill No. 6 is the one farthest upstream, and was the one first constructed. The work then proceeded downstream to No. 1, which was the last one of the main sills completed. Each sill, except Nos. 2 and 3*a*, is built upon a foundation mat and the elevation of each, minus an allowance for settlement and compression, coincides with the original slope of the revetted bank. No. 2 fault being of small extent and having a hard bottom it was deemed safe to dispense with the foundation mat. Sill No. 3*a* is founded upon the original paving of the bank.

The foot mats are all of the fascine type. Briefly described, their method of construction was as follows: Short stakes were driven 8 feet apart on a line designating the head of the mat, and corresponding stakes at the foot of it. The $\frac{5}{16}$-inch bottom cables were tautly stretched from the first head to the corresponding foot stake, and so on for the entire number. Enough brush to make a 12-inch fascine was then laid upon these cables and after being formed into a fascine was sewed into the mat with a $\frac{1}{4}$-inch strand. This was continued until the requisite length of mat had been constructed. As these mats were built directly upon the ground and consequently would not be subjected to any strains, top cables and grillages were omitted. All the material had to be carried or wheeled from the barges up to the place of work.

As soon as a mat was completed, its surface—except that part of it which would be covered by the sill—was completely covered with stone. The part corresponding to the base of the sill was left bare. The sills were built up of two or more cribs, according to the height of structure required, each crib being composed of brush, each layer perpendicular to the one next below, and the whole well compressed and tied together with galvanized-wire ties. Each crib was covered with stone enough to overcome its buoyancy, but the topmost crib was completely paved, both on the crown and the slopes.

The bottom crib of each sill is a plain rectangle in section, but each succeeding crib is so placed that a strip 3 feet wide is left uncovered on the downstream side of the underlying one, while on the upstream face they are so built that when the whole structure was completed this face would have a slope of about 1 on 2½. The crowns are 8 feet wide. The angles on the downstream side, formed by the offsets, were filled with brush in such a manner that this side would have a slope of 1 on 1½. The slopes and crown were then heavily paved.

Sill No. 3*a* is built across a flat formed by the subsidence, during the flood of 1897, of a portion of the revetted bank. It extends at its highest elevation to a little above mid stage. As the pavement where this sill is placed was found practically intact no foundation mat was placed.

During the progress of the work as the river receded, several minor faults were discovered. The repair of these necessitated the construction of one small connecting mat, containing 27 squares, and some redressing and repaving of the slope.

All sills were well anchored into the bank at their shore ends, recesses for the reception of these ends being excavated into the bank. At the angles formed by the faces of the bank and sills, spalls and riprap were thickly piled so as to prevent any possible cutting around the ends.

Brush and poles were furnished by contract at $0.87½ and $2 per cord, respectively, delivered on United States barges and towed by United States steamers.

Quarters and subsistence were furnished to the overseer in charge, to the clerk, master laborers, and watchmen.

The pay for laborers was $1.20 per day. An arrangement was entered into with the ferry company under which transportation to and from the works was furnished at $0.15 for the round trip. This was paid by the United States.

Work was completed December 16. A summary of the work done, together with an abstract of the cost thereof, is given below:

River mat, 308 squares.

455.84 cords brush	$398.86
283.36 cubic yards stone	151.88
1,324.4 pounds No. 12 galvanized wire	24.50
862.4 pounds 5/16-inch strand	22.85
15 ¼-inch clips	.98
650 bushels coal	83.20
Superintendence	65.81
29 cords poles	58.00
185 pounds silicon bronze wire	29.60
1,262.8 pounds ¼-inch strand	38.52
50.5 pounds staples	1.01
661 5/16-inch clips	24.79
Labor	535.00
Subsistence	68.52
Care of plant	45.80

Cost of river mat, $1,549.32; cost per square, $4.98.

Connecting mats, 2; aggregate, 81 squares.

113.5 cords brush	$99.31
90 cubic yards stone	48.24
405 pounds No. 12 galvanized wire	7.48
227 pounds 5/16-inch strand	6.01
167 5/16-inch clips	6.26
Labor	272.20
Subsistence	29.89
8.5 cords poles	17.00
35 pounds silicon bronze wire	5.60
340 pounds ¼-inch strand	10.36
14 pounds staples	.28
162 bushels coal	20.74
Superintendence	33.48
Care of plant	23.04

Cost of connecting mats, $579.90; cost per square, $7.107.

Sill mats, 5; aggregate, 310 squares.

458 cords brush	$400.75
1,270 pounds ¼-inch strand	38.74
868 pounds 5/16-inch strand	23.00
Labor	686.95
Subsistence	69.70
315 cubic yards stone	168.84
51.5 pounds staples	1.03
600 bushels coal	76.80
Superintendence	84.50
Care of plant	47.00

Cost of sill mats, $1,597.31; cost per square, $5.152.

Sills, 7; total yardage, 3,160.24, equal to 82,021.7 cubic feet.

1,236.1 cords brush	$1,081.56
37.8 cords poles	75.60
2,177.2 pounds ¼-inch strand	66.40
76 pounds staples	1.52
Labor	2,743.11
Subsistence	186.65
769.84 cubic yards stone	412.83

3,385.6 pounds No. 12 galvanized wire	$62.64
987 pounds $\frac{5}{16}$-inch strand	26.18
3,266.5 bushels coal	418.11
Superintendence	337.40
Care of plant	172.75

Cost of sills, $5,584.55; cost per cubic yard, $1.767; cost per cubic foot, $0.0655.

Grading bank (5,188 cubic yards).

Oils and other supplies	$15.60
140 bushels coal	17.92
Superintendence	13.50
Labor	89.20
Subsistence	9.80
Care of plant	2.75

Cost of grading, $148.77; cost per cubic yard, $0.0285.

Paving bank (2,569.5 square yards).

1,027.8 cubic yards stone	$550.90
Labor	314.12
Subsistence	36.40
680 bushels coal	87.03
Superintendence	38.64
Care of plant	30.00

Cost of paving, $1,057.09; cost per square yard, $0.4114.

RECAPITULATION.

Cost of river mat	$1,549.32
Cost of connecting mats	579.90
Cost of sills	5,584.55
Cost of sill mats	1,597.31
Cost of grading	148.77
Cost of paving	1,057.09
Cost of transportation	123.15
Cost of lumber	24.40
Total cost of work	10,664.49

The cost of stone used on this work has been taken at $0.536 per cubic yard, which represents the cost of loading on barges and towing from Fletchers Bend to the work and towing empties to the former place. Including the first cost, the actual cost of the stone used in this work was $1.537 per cubic yard.

Memphis Harbor.—Soundings taken during the preceding summer over the citizens' protection works, constructed in 1886–87, which consist of submerged spurs built normal to the shore line, gave evidence of some settlement of portions of Dikes No. 2, 2½, and 3. The maximum settlement, both as regards depth and amount of dike involved, was in No. 2½, that in No. 2 being of relatively small depth and extent, while none of the then submerged parts of No. 3 were affected, the damage to this dike being all in that part that lay just below the high-water stage. In No. 2½ the settlement amounted to as much as 18 feet below the original elevation of the work, while the length of the damaged portion was 225 feet, beginning 40 feet inshore of the zero contour. Dike No. 2 showed two depressions, one beginning 50 feet inshore of the zero contour, 110 feet long with a maximum depth below the original elevation of 7 feet, while the other, which lay between the 13-foot and 23-foot contour, was 65 feet long by 4 feet deep. In Dike No. 3 a depression 100 feet long and 6 feet deep lay between the 21-foot and 35-foot contours.

The method of repair adopted for these faults was to construct brush and pole cribs containing pockets for the reception of the stone ballast, of proper size, and place them so as to restore the original elevation and dimensions of the damaged spurs.

The cribs for the submerged faults were built between barges anchored over the damaged parts. When completed and ballasted they were lowered into place. On the dry portions the repair work was built directly in place. For the repair of the large fault in Dike No. 2½, two cribs, founded upon a fascine foot mat, were required. One small connecting mat was also required for the proper protection of the shore end of the repairs on this dike. All other faults were repaired with a single crib each.

All labor was self-subsisting, and paid for at the rate of $1.20 per day.

Summary of work done at Memphis Harbor, materials expended, cost of each class of work, cost per unit, and total cost:

Sill mat (133 squares).

168.9 cords brush	$147.79
10 cords poles	20.00
100 cubic yards stone	53.60
70 pounds silicon bronze wire	11.20
492 pounds No. 12 wire	9.10
1,040 pounds ½-inch strand	31.72
690 pounds 5/16-inch strand	18.29
26 pounds staples	.50
120 5/16-inch clips	5.64
13 ½-inch clips	.85
Labor	480.20
Superintendence	29.20

Cost of sill mat, $808.09; cost per square, $6.076.

Connecting mat (25 squares).

120.3 cords brush	$105.26
10 cords poles	20.00
50 cubic yards stone	26.80
100 pounds No. 10 wire	1.70
200 pounds No. 12 wire	3.70
50 pounds 5/16-inch strand	1.32
Labor	105.26
Superintendence	6.40

Cost of connecting mat, $270.44; cost per square, $10.43.

Crib No. 1, Dike No. 2 (3,525 cubic feet).

25 cords brush	$21.87
8.81 cords poles	17.62
33 cubic yards stone	17.69
231.6 pounds No. 12 wire	4.28
123 pounds 5/16-inch strand	3.26
Labor	95.53
Superintendence	5.81

Cost of crib, $166.06; cost per cubic foot, $0.0471.

Crib No. 2, Dike No. 2 (1,320 cubic feet).

9.37 cords brush	$8.19
3.3 cords poles	6.60
12.35 cubic yards stone	6.62
86.7 pounds No. 12 wire	1.60
49.25 pounds 5/16-inch strand	1.31
Labor	35.77
Superintendence	2.17

Cost of crib, $62.26; cost per cubic foot, $0.0471.

Crib No. 1, Dike No. 2½ (25,320 cubic feet).

179.77 cords brush	$157.30
62.04 cords poles	124.08
237 cubic yards stone	127.03
1,063.52 pounds No. 12 wire	19.68
600 pounds No. 10 wire	10.20
883.67 pounds 5/16-inch strand	23.42
Labor	686.17
Superintendence	41.71

Cost of crib, $1,189.59; cost per cubic foot, $0.0469

Crib No. 2, Dike No. 2½ (11,100 cubic feet).

78 80 cords brush	$68.95
27.75 cords poles	55.50
103.96 cubic yards stone	55.72
729.27 pounds No. 12 wire	13.49

387.40 pounds strand	$10.26
Labor	300.81
Superintendence	18.30

Cost of crib, $523.03; cost per cubic foot, $0.0471.

Crib No. 3, Dike No. 2½ (5,126 cubic feet).

36.39 cords brush	$31.84
12.81 cords poles	25.62
48 cubic yards stone	25.73
338.95 pounds No. 12 wire	6.27
178.90 pounds strand	4.74
Labor	138.92
Superintendence	8.48

Cost of crib, $241.60; cost per cubic foot, $0.0471.

Repairs to Dike No. 3 (2,675 cubic feet).

19.88 cords brush	$17.39
7 cords poles	14.00
26.20 cubic yards stone	14.04
183.96 pounds No. 12 wire	3.40
97.78 pounds strand	2.59
Labor	75.88
Superintendence	4.61

Cost of repairs, $131.91; cost per cubic foot, $0.0493.

RECAPITULATION.

Sill mat	$808.09
Connecting mat	270.44
Crib No. 1, Dike No. 2	166.06
Crib No. 2, Dike No. 2	62.26
Crib No. 1, Dike No. 2½	1,189.59
Crib No. 2, Dike No. 2½	523.03
Crib No. 3, Dike No. 2½	241.60
Repairs to Dike No. 3	131.91
Subsistence	49.12
Total	3,442.10

New Madrid, Mo.—No work was done here during the year. I would respectfully renew my recommendation for a further extension downstream of 1,000 feet of the existing revetment.

This would complete the protection of the entire river frontage of the town.

Plumpoint Reach (*Arkansas side*).—No work was done here during the year. The continuation of the Fletchers Bend revetment up to the mouth of Mill Bayou, and the revetment of Osceola Bar from New Haven down to the head of the 1895 work is again respectfully urged for the reasons set forth in my last annual report.

Navigation over this reach was not interrupted during the entire low-water season, and the low-water channels have remained fixed for the past two years.

The bankheads designed by Lieutenant-Colonel Stickney, and placed at the ends of the "interrupted" revetment in Fletchers Bend, appear to have admirably answered their purpose.

Respectfully submitted.

AUG. J. NOLTY, *Assistant Engineer.*

First Lieut. MASON M. PATRICK,
Corps of Engineers, U. S. A.

Abstract of proposals for dredging in Wolf River, Tennessee, received in response to advertisement dated June 16, 1897, and opened July 15, 1897, by First Lieut. Mason M. Patrick, Corps of Engineers.

No. of proposal.	Name of bidder.	Residence.	Dredging per cubic yard.	Removing obstructions per hour.
			Cents.	
1	Chas. H. Appleton	Quincy, Ill	20	$10.00
2	Rittenhouse R. Moore	Mobile, Ala	20	15.00
3	Kavanaugh Sand Co	Memphis, Tenn	19½	10.00
4	Wm. A. Kirk	Madison, Ind	*a* 12	*a* 9.00
5	H. S. Brown	Quincy, Ill	20	10.00

a Lowest bid; accepted.

Abstract of proposals for levee work received in response to advertisement dated July 24, 1897, and opened August 16, 1897, by First Lieut. Mason M. Patrick, Corps of Engineers.

No. of proposal.	Name and residence of bidder.	Lower St. Francis Levee district.						
		Caruthersville.	Half Moon Bayou.	Lintdale.	Midway.	Crooked Bayou.	J. B. Driver.	J. D. Driver.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
3	Wilson & Co., Golden Lake, Ark							
4	Wm. H. Huffman, Caruthersville, Mo	*a* 9½	*a* 9½	*a* 9½	*a* 9½			
7	T. Mike, Gayoso, Mo	11¾	16	12	13½			
11	John Burke, Vicksburg, Miss						16	16
12	L. C. Dresbach, Memphis, Tenn						12¾	13½
13	The J. S. McTighe Banking, Construction, and Internal Improvement Co., Memphis, Tenn	11.93	20	13¾	13.24	*b* 24	13.13	12½
14	Morrow & Carter, Memphis, Tenn	11.10	16	13	14	*b* 16	11.64	11.64
15	Berry & Adams, Pecan Point, Ark							
19	Jas. H. Cary, Memphis, Tenn	9.74	9.74	9.74	9.74		*a* 11	*a* 11
21	Shippey & Johnson, Memphis, Tenn							
22	J. F. Keeney, Cairo, Ill	14						
23	J. E. Kerr, Memphis, Tenn	14	24	17.80	17.40	*b* 24	18	18
25	F. A. McClelland, Columbus, Miss						11.99	11.99
26	Martin Jennings & Co., Memphis, Tenn	14¼	17½	14¼	14¼	*b* 20¾	14	14
27	Arnold & De Garis, Memphis, Tenn	11.90		11.80	11.80		12.10	12.10
28	George A. McBain, Memphis, Tenn						13.45	13.45

No. of proposal.	Name and residence of bidder.	Lower St. Francis Levee district.						
		Griders.		Nodena.	New levee 83 M. to 85 M.	Enlargement and repair.		
		No. 1.	No. 2.			80 M. to 83 M.	92 M. to 94 M.	104 M. to 109 M.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
3	Wilson & Co., Golden Lake, Ark			12				
4	Wm. H. Huffman, Caruthersville, Mo							
7	T. Mike, Gayoso, Mo			13.74				
11	John Burke, Vicksburg, Miss	20	16	15	14			*b* 19
12	L. C. Dresbach, Memphis, Tenn	12½	12.20	11¾	12.23	14	15	
13	The J. S. McTighe Banking, Construction, and Internal Improvement Co., Memphis, Tenn	15	12.95	12.83	11.93	18	17	*b* 17½
14	Morrow & Carter, Memphis, Tenn	11.64	11.64	10.74				
15	Berry & Adams, Pecan Point, Ark				12.40			
19	Jas. H. Cary, Memphis, Tenn	*a* 11	*a* 11	*a* 11	*a* 11	*a* 11	*a* 11	
21	Shippey & Johnson, Memphis, Tenn				11.98			
22	J. F. Keeney, Cairo, Ill			17⅞	17½			
23	J. E. Kerr, Memphis, Tenn	13	12½	10.80	11	15	15	*b* 25
25	F. A. McClelland, Columbus, Miss			12.99				
26	Martin Jennings & Co., Memphis, Tenn	14	14	13	14	18⅝	16⅝	*b* 18⅝
27	Arnold & De Garis, Memphis, Tenn	16	13	12.20	12.90			
28	George A. McBain, Memphis, Tenn	13.45	13.45	13.45	11.45	14.45		

a Accepted. *b* Rejected.

Prices bid are per cubic yard.

NOTE.—James H. Cary will take all or none of first four items bid on and all or none of next eight items.

Abstract of proposals for levee work received in response to advertisement dated July 24, 1897, and opened August 16, 1897, by First Lieut. Mason M. Patrick, Corps of Engineers.

No. of proposal.	Name and residence of bidder.	White River Levee district.										
		Williamson's.										
		First section.	Second section.	Fitzhugh.	Westover.	Schoolhouse Bayou.	Ferguson's.	Wood Cottage.	Henrico.	Huntington.	Repairs near Westover.	Filling gap above Williamson's.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cts.*	*Cents.*
1	Geo. J. Webb, jr., Venice, Ill											14½
2	E. B. Mantle, Memphis, Tenn							18				
5	Jno. G. Sessions, Leota Landing, Miss	*a*12.93	15.93									
6	J. H. Welsch, Barton, Ark			25	35	30						
8	H. F. Watkins, Beulah, Miss							15.45		13.45		
9	Jno. Scott & Sons, St. Louis, Mo	13.39	13.39									16.43
10	F. W. Hunt, Bellair, Md	16½	*a*18									
12	L. C. Dresbach, Memphis, Tenn					20½	18.40	16	17.40	*a*13		
13	The J. S. McTighe Banking, Construction, and Internal Improvement Co., Memphis, Tenn	13.97	14.23	*a*15	*a*15	*a*18	18	18	17	15	*a*18	17
17	W. M. Forrest, Memphis, Tenn						19	16	18½			
19	Jas. H. Cary, Memphis, Tenn	14.90						*a*14				
20	J. W. Thompson, Memphis, Tenn			17½	17½							
21	Shippey & Johnson, Memphis, Tenn					19			*a*15.44	14.49		
23	J. E. Kerr, Memphis, Tenn	17	18	24								17
24	McCadden Construction Co., Memphis, Tenn	13.95	13.95									17.40
25	F. A. McClelland, Columbus, Miss											*a*12.99
26	Martin Jennings & Co., Memphis, Tenn	15.60	13.60	24		20½	21	19	19	18		17
30	J. B. Lewis, Gaines Landing, Ark						*a*17½	14.78	19½	17		

a Accepted.

Prices bid are per cubic yard.

Abstract of proposals for levee work received in response to advertisement dated July 24, 1897, and opened August 16, 1897, by First Lieut. Mason M. Patrick, Corps of Engineers.

No. of proposal.	Name and residence of bidder.	Upper Yazoo Levee district.						
		Enlargement.						Hauling earth over levee.
		South half sec. 76.	Sec. 77.	Sec. 78.	Sec. 79.	Sec. 80.	Sec. 81.	
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
2	E. B. Mantle, Memphis, Tenn	*a* 13½						
5	Jno. G. Sessions, Leota Landing, Miss	27.78	27.73					4
16	T. S. Aderholdt, Friars Point, Miss	17.47	19½	21½	24½	*b* 21½	*b* 17.74	
18	C. H. Dameron, Huntsville, Mo	18	19	23	23.99	*b* 22	*b* 19	
23	J. E. Kerr, Memphis, Tenn	14.80	31	31	31	*b* 23	*b* 23	6
26	Martin Jennings & Co., Memphis, Tenn	18	19	24½	22	*b* 22	*b* 18	5
27	Arnold & De Garis, Memphis, Tenn	17½	19½	21	24	*b* 19½	*b* 17½	5
29	Reese Thomas, Rosedale, Miss	16.99	*a* 16.99	*a* 16.99	*a* 16.99	*b* 16.99	*b* 16.99	1½

a Accepted. *b* Rejected.

Prices bid are per cubic yard.

Abstract of proposals for levee work in Lower St. Francis and Upper Yazoo Levee districts received in response to public notice dated August 18, 1897, and opened August 30, 1897, by First Lieut. Mason M. Patrick, Corps of Engineers.

No. of proposal.	Name and residence of bidder.	Lower St. Francis Levee district.		Upper Yazoo Levee district. Enlargement north half sec. 80.
		Closing Crooked Bayou Crevasse.	Enlargement and repair 104 M. to 109 M.	
		Cents.	*Cents.*	*Cents.*
1	Charles E. Adams, Pecan Point, Ark	....	16⅞	16⅞
2	Shippey & Johnson, Memphis, Tenn	19	19	21.49
3	J. W. Thompson & Co., Memphis, Tenn	31	23	25
4	Martin Jennings & Co., Memphis, Tenn	....	18⅛	17⅛
5	Jas. H. Cary, Memphis, Tenn	20	*a* 16½	22
6	T. S. Aderholdt, Friars Point, Miss	....	....	19⅛
7	W. F. Watkins, Beulah, Miss	....	....	*b* 19.99

a Accepted. *b* Five cents additional for hauling earth over levee.

Prices bid are per cubic yard.

NOTE.—Bids for work at Crooked Bayou and enlargement north half of section 80 rejected.

Abstract of proposals for furnishing brush, poles, wire, wire strand, and staples, received in response to notice dated September 13, 1897, and opened September 21, 1897, by First Lieut. Mason M. Patrick, Corps of Engineers.

No. of proposal.	Name and residence of bidder.	Willow brush, per cord.	Willow poles, per cord.	Galvanized steel wire.		Wire strand.		Staples 1½ inches, per pound.
				No. 10, per pound.	No. 12, per pound.	⅜ inch, per pound.	5/16 inch, per pound.	
				Cents.	*Cents.*		*Cents.*	*Cents.*
1	Jos. Evins, Dardanelle, Ark	$1.00	$1.65	....	....	....	....	....
2	Hunter & Frey, Memphis, Tenn	*a* 87½	*a* 1.50	....	....	....	....	....
3	Livermore Foundry and Machine Co., Memphis, Tenn	....	....	*b* 1.75	1.90	*c* $2	*c* 88	*b* 2
4	Manogue-Pidgeon Iron Co., Memphis, Tenn	....	....	*b* 1.75	1.95	*Cents.* 2.83	2.69	*b* 2
5	Orgill Bros. & Co., Memphis, Tenn	....	....	1.85	*a* 1.85	2.65	*a* 2.65	2.15
6	Lee Bros., Memphis, Tenn	....	....	....	....	*a* 2.60	2.70	....

a Accepted.
b Tie bids, settled by bidders between themselves.
c Per 100 feet.

Abstract of proposals for levee work at Walnutbend, Ark., received in response to public notice dated September 28, 1897, and opened October 9, 1897, by First Lieut. Mason M. Patrick, Corps of Engineers.

No. of proposal.	Name and residence of bidder.	Closing breaks, per cubic yard.	Enlargement and repairs, per cubic yard.	Remarks.
		Cents.	*Cents.*	
1	Martin Jennings & Co., Memphis, Tenn	15.41	18.41	
2	C. H. Dameron, Memphis, Tenn	18	18	Will take all or none.
3	Shippey & Johnson, Memphis, Tenn	*a* 15.99	*a* 15.99	Do.
4	The J. S. McTighe Banking, Construction, and Internal Improvement Co., Memphis, Tenn.	19.93	19.93	Will take all or none, or will take sections A, B, C, and D at 18.20 cents.
5	McCadden & Co., Memphis, Tenn	17	25	
6	Jas. H. Cary, Memphis, Tenn	19.24	19.24	Will take all or none.

a Accepted.

List of contracts in force April 30, 1898, in First and Second districts, improving Mississippi River.

Name.	For what made.	Date of approval.	Date of beginning work.	Expiration of contract.	Remarks.
		1897.	1897.	1898.	
Reese Thomas	Levee work in Upper Yazoo Levee district.	Oct. 4	Aug. 24	Feb. 15	Time of completion extended to Aug. 1, 1898.
E. B. Mantle	....do	....do	Nov. 16	....do	Time of completion extended to June 1, 1898.
The J. S. McTighe Banking, Construction and Internal Improvement Co.	Levee work in White River Levee district.	Oct. 16	Sept. 20	....do	Time of completion extended to Sept. 1, 1898.

Details of levee work, White River Levee district, from May 1, 1897, to April 30, 1898.

["R" represents right bank of river. "H" represents stations from Helena, Ark., southward. "L" represents stations from near Laconia, Ark., northward.]

Station.	Distance from Cairo.	Contractor.	Length of contract.	Cubic yards in contract as estimated.	Cubic yards actually put in place.	Total.		
						Laborers.	Teams.	Scrapers.
	Miles.		*Feet.*					
1+88 H to 41 H	309 R.	F. A. McClelland	3,912	50,000	58,878	1,986	1,439	1,022
47+20 H to 120 H	309 R.	Jno. G. Sessions	7,300	220,000	215,962	8,827	6,555	4,710
120 H to 190+88 H	309 R.	F. W. Hunt	7,088	220,000	222,780	9,661	6,930	5,042
285+10 H to 296+35 H.	311 R.	J. S. McTighe Co	1,125	56,000	37,820	1,707	1,134	768
722+66 H to 730 H	321 R.	.....do	734	20,000	16,682	974	605	898
707 H to 722+66 H, and 730 H to 742 H.	321 R.	.....do	2,766	58,000	18,877	1,151	879	592
900 H to 994 H	327 R.	P. McCadden	9,400	44,000	18,809	(a)	(a)	(a)
1727+80 H to 1759+57 H.	342 R.	J. S. McTighe Co	3,177	60,000	6,936	......	......	......
994+20 L to 1007+73 L.	364 R.	J. B. Lewis	1,353	32,000	23,333	1,815	810	608
Force account	364 R.	.....do	......	......	3,105	......	......	......
911+53 L to 926+90 L, and 933+34 L to 947+52 L.	365 R.	Jas. H. Cary	2,955	50,000	49,696	1,916	1,814	911
240+19 L to 261+94 L.	384 R.	Shippey & Johnsen	2,175	70,000	65,200	4,503	2,290	1,582
128+95 L to 140+98 L.	385 R.	L. C. Dresbach	1,203	25,000	23,583	(a)	(a)	(a)
Total	......	......	43,183	900,000	756,656	......	......	......

Station.	Distance from Cairo.	Contractor.	Yardage.		Price per cubic yard.	Average height of levee.	Average haul.	Remarks.
			Per team.	Per scraper.				
	Miles.				*Cents.*	*Feet.*	*Feet.*	
1+88 H to 41 H	309 R.	F. A. McClelland	40.91	57.60	12.99	15.00	130	New levee and enlargement.
47+20 H to 120 H	309 R.	Jno. G. Sessions	32.94	45.85	12.93	14.00	175	New levee.
120 H to 190+88 H	309 R.	F. W. Hunt	32.15	44.18	13.00	13.50	175	Do.
285+10 H to 296+35 H.	311 R.	J. S. McTighe Co	33.35	49.24	15.00	16.20	210	Do.
722+66 H to 730 H	321 R.	.....do	27.57	42.50	15.00	15.10	215	Do.
707 H to 722+66 H, and 730 H to 742 H.	321 R.	.....do	21.48	31.88	18.00	15.10	160	Enlargement.
900 H to 994 H	327 R.	P. McCadden	(a)	(a)	15.70	10.50	265	Do.
1727+80 H to 1759+57 H.	342 R.	J. S. McTighe Co	......	......	18.00	16.00	175	New levee unfinished.
994+20 L to 1007+73 L.	364 R.	J. B. Lewis	28.81	38.37	17.50	13.70	195	New levee.
Force account	364 R.	.....do	......	......	......	......	......	Cost, $654.17.
911+53 L to 926+90 L, and 933+34 L to 947+52 L.	365 R.	Jas. H. Cary	37.82	54.55	14.00	12.50	175	New levee.
240+19 L to 261+94 L.	384 R.	Shippey & Johnsen	28.47	41.21	15.44	13.50	190	Do.
128+95 L to 140+98 L.	385 R.	L. C. Dresbach	(a)	(a)	13.00	15.10	......	New levee and enlargement.

[a] Combined scraper and wheelbarrow work.

Detail of levee work, Lower St. Francis Levee district, from May 1, 1897, to April 30, 1898.

[$\frac{26}{3}$ represents 26 miles + 3,000 feet; R represents right bank of river.]

Stations.	Distance from Cairo.	Contractor.	Length of contract.	Cubic yards in contract as estimated.	Cubic yards actually put in place.	Total.		
						Laborers.	Teams.	Scrapers.
	Miles.		*Feet.*					
$\frac{26}{30}$ to $\frac{45}{32+79}$	109 R to 127 R.	W. H. Huffman	22,047	138,000	108,953	5,818	5,069	4,618
$\frac{61}{6+80}$ to $\frac{61}{7+85}$	153 R	Adams & Berry	105	2,600	2,600	(a)	(a)	(a)
$\frac{80}{7+72}$ to $\frac{84}{30}$ and $\frac{85}{45+82}$ to $\frac{95}{27+86}$.	165 R to 179 R.	Jas. H. Cary	47,002	299,700	300,368	11,667	7,443	5,078
$\frac{84}{30}$ to $\frac{85}{32+50}$ $\frac{104}{10}$ to $\frac{104}{31}$	169 R 193 R	do	8,630	86,000	84,375	5,834	3,721	2,536
$\frac{70}{30}$ to $\frac{71}{17}$	161 R	do	3,180	50,000	39,305	(a)	(a)	(a)
Walnut Bend Levee A to $\frac{G}{3+20}$.	275 R to 282 R.	Shippey & Johnsen	31,400	162,000	80,085	3,960	2,525	1,899
Totals			112,364	738,300	615,686			

Stations.	Distance from Cairo.	Contractor.	Yardage.		Price per cubic yard.	Average height of levee.	Average haul.	Remarks.
			Per team.	Per scraper.				
	Miles.				*Cents.*	*Feet.*	*Feet.*	
$\frac{26}{30}$ to $\frac{45}{32+79}$	109 R to 127 R.	W. H. Huffman	21.29	23.59	9.50	8.80	240	New work and repairs. Work done by drag scrapers.
$\frac{61}{6+80}$ to $\frac{61}{7+85}$	153 R	Adams & Berry	(a)	(a)	15	19	175	Filling out in levee.
$\frac{80}{7+72}$ to $\frac{84}{38}$ and $\frac{85}{45+82}$ to $\frac{95}{27+86}$.	165 R to 179 R.	Jas. H. Cary	40.36	59.15	11	7.80	287	Enlargement and new work.
$\frac{84}{30}$ to $\frac{85}{32+50}$ $\frac{104}{10}$ to $\frac{104}{31}$	169 R 193 R	do	22.67	33.27	16.25	12.25	180	New work and enlargement.
$\frac{70}{30}$ to $\frac{71}{17}$	161 R	do	(a)	(a)	15	10.10	198	Enlargement.
Walnut Bend Levee A to $\frac{G}{3+20}$.	275 R to 282 R.	Shippey & Johnsen.	31.71	42.17	15.99	13	150	Enlargement and new work (unfinished).
Totals								

[a] Record incomplete.

Details of levee work, Upper Yazoo Levee district, from May 1, 1897, to April 30, 1898.

[Sections are 5,200 and 5,300 feet in length; L represents the left bank of river.]

Stations.	Distance from Cairo.	Contractor.	Length of contract.	Cubic yards in contract as estimated.	Cubic yards actually put in place.	Total.		
						Laborers.	Teams.	Scrapers.
	Miles.		*Feet.*					
3986 to 4013, section 76..	329 L....	E. B. Mantle	2,700	55,000	35,871	1,740	1,148	850
4013 to 4171, sections 77, 78, 79.	331 L....	Reese Thomas	15,800	375,000	204,102	14,637	9,448	6,587
4171 to 4277, sections 80, 81.	333 L....	Martin Jennings & Co.	10,600	50,000	48,728	3,346	2,229	1,560
Totals	....	....	29,100	480,000	288,701	......	......	......

Stations.	Distance from Cairo.	Contractor.	Yardage.		Price per cubic yard.	Average height of levee.	Average haul.	Remarks.
			Per team.	Per scraper.				
	Miles.				*Cents.*	*Feet.*	*Feet.*	
3986 to 4013, section 76..	329 L....	E. B. Mantle	31.24	42.20	13.25	14.20	175	Enlargement (unfinished).
4013 to 4171, sections 77, 78, 79.	331 L....	Reese Thomas	21.60	30.98	16.99	18	200	Enlargement (unfinished).
4171 to 4277, sections 80, 81.	333 L....	Martin Jennings & Co.	21.86	31.23	16¼	17.50	192	Enlargement.
Totals	....	....	......	......	......	......	......	

List of civilian engineers employed on work of river and harbor improvements, in charge of First Lieut. Mason M. Patrick, Corps of Engineers, from May 1, 1897, to April 30, 1898.

Name and residence.	Time employed.	Compensation per month.	Where employed.	Work on which employed.
	Months.			
W. M. Rees, Memphis, Tenn.	12	$250	Memphis, Tenn.......	Principal office assistant, general superintendence of construction; plans for work at various localities.
Aug. J. Nolty, Memphis, Tenn.	12	175	Memphis, Tenn., and Hopefield Bend, Ark.	Care and repair of plant; construction and repair of revetment at Hopefield Bend, Ark., and Memphis, Tenn.
Wm. Gerig, Memphis, Tenn.	11	150	Jeffersonville, Ind., Memphis, Tenn., and Askew, Ark.	Construction of U. S. S. *Chisca;* dredging in Wolf River; construction and repair of Walnut Bend Levee.
Chas. Le Vasseur, Memphis, Tenn.	12	150	Memphis, Tenn., and in the field.	Surveys, gauges, and observations; draftsman and computer in office.
A. F. Kilpatrick, Memphis, Tenn.	8 4/30 3 26/30	165 150	Osceola, Ark., and Memphis, Tenn.	Construction and repair of levees in Lower St. Francis Levee district.
M. Gardner, Memphis, Tenn.	8 18/30 3 12/30	140 125	Stoval, Miss., and Memphis, Tenn.	Construction and repair of levees in Upper Yazoo Levee district.
C. H. Purvis, Helena, Ark.	12	140	Helena, Ark	Construction and repair of levees in White River Levee district.
L. Engstfeld, Memphis, Tenn.	8	125	Memphis, Tenn.......	Miscellaneous office work.
Fred. Wigstrand, Laconia, Ark.	1/30	125	Laconia, Ark	Construction and repair of levees in White River Levee district.

APPENDIX 3.

REPORT OF CAPT. H. C. NEWCOMER, CORPS OF ENGINEERS, UPON OPERATIONS IN THE THIRD DISTRICT.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., May 20, 1898.

COLONEL: I have the honor to submit the following report of operations in the Third district, improving Mississippi River, from May 1, 1897, to May 1, 1898:

The Third district extends from the Coahoma-Bolivar County line on the left bank (365 L) and the mouth of the White River on the right bank (393 R) to the latitude of Warrenton, Miss. (607 L). In its improvement, works of bank protection have been executed at Lake Bolivar Front, Ashbrook Neck, Greenville Harbor, Lake Providence Reach, and Delta Point; the systematic improvement of Lake Providence Reach was attempted, and levees have been constructed and enlarged in the Upper Tensas and Lower Yazoo levee districts. All of these localities are shown on the accompanying map of the Third district.

The operations of the past year have included repairs to the broken revetment at Ashbrook Neck, Greenville, Lake Providence, and Delta Point, the construction and maintenance of levees, towing stone, the construction of a towboat, and the care of plant.

LAKE BOLIVAR FRONT (417 MILES BELOW CAIRO).

The revetment at this place was built to hold a bank whose caving endangered a large levee across the head of Lake Bolivar. About 4,250 linear feet of revetment were constructed in 1888-89, and repairs were made in 1889, 1892, and 1893. Details of the work are given in the Annual Reports of 1889, page 2704; 1890, page 3252; 1893, page 3752, and 1894, page 2919; and maps accompany the reports of 1889 and 1890.

No work has been done since 1894. The surveys of recent years show a fill over the revetment, and it is protected by a bar making downstream from the foot of Island No. 76. With the exception of three small breaks in the upper bank paving, that first appeared after the flood of 1897, and have not shown any tendency to enlarge, the revetment is apparently in good condition for a length of about 3,775 feet, measured along the shore edge of the mats. No extension is considered necessary. The total expenditures have been $145,358.04.

ASHBROOK NECK (446 MILES BELOW CAIRO).

The revetment at this place was built to prevent a threatened cut-off. About 2,820 linear feet of revetment were constructed in 1890-91, 4,300 feet in 1891-92, 2,610 feet in 1892-93, 1,475 feet in 1894-95, and repairs to upper bank paving were made in 1893-94.

A levee 7,300 feet long was built along the axis of the neck in 1891-92 to prevent flow across the neck, but it was destroyed in the next flood. Details of the work are given in the Annual Reports of 1891, page 3639; 1892, page 3170; 1893, page 3752; 1894, page 2920, and 1895, page 3805. Maps accompany the reports of 1892 and 1893.

Early in June, 1897, a break appeared in the revetment, Stations 83 to 86, and later in the season another at Stations 93 to 96, and also a defect in the upper bank, Stations 105 to 108. July 31, 1897, I submitted a project for repairs to the broken revetments in the Third district, but work was not begun at Ashbrook Neck until December 13, when the plant could be spared from Greenville Harbor. It was found that the breaks extended but little below low water, so that the full-sized channel mats were not required. Four shore mats, aggregating 757 squares, were built, and about 1,130 squares of the upper bank were regraded and repaved. The total cost of the repairs was $13,249.53. The details of the work are given in the appended report of Assistant Engineer Arthur Hider.

The revetment appears to be in effective condition for a length of about 9,990 feet, measured along the shore edge of mats. No extension is considered necessary, but new defects requiring repairs may appear after this year's flood. The total expenditures have been $442,271.26.

GREENVILLE HARBOR (478 MILES BELOW CAIRO).

The revetment at this place was built to protect the town of Greenville, which was rapidly caving into the river when the work began in 1887. The first project was to hold the bank with submerged spur dikes consisting of cribs resting on foundation mats. In 1887, 1888, and 1889 twelve crib dikes were built, and one longitudinal pile dike, and mats were placed between some of the spur dikes. Caving continued, however, in the bend above; and during the flood of 1891 the upper dikes were flanked, four spur dikes and the longitudinal dike being carried away. The revetment of the bank above the remaining dikes was then begun, 6,600 linear feet being built in 1891-92, 4,450 feet in 1892-93, and 3,087 feet in 1894-95, woven mats being used in all this work. Repairs were made to upper bank paving in 1893 and 1894. In the flood of 1894 the upper remaining spur dike was carried away, leaving seven spur dikes still in position. In 1896 a break in the revetment at Station 54 was repaired by the construction of about 677 linear feet of new revetment, using fascine mats.

The details of the above operations are given in the Annual Reports of 1888, page 2280; 1889, page 2706; 1890, page 3240; 1892, page 3173; 1893, page 3753; 1894, page 2920; 1895, page 3805, and 1897, page 3726. Maps accompany the reports of 1888, 1889, 1890, 1892, and 1893.

On April 5, 1897, while the flood of that year was near its height, a break in the revetment near Station 24 became evident through the sinking of a tree that had stood on the bank. There was considerable anxiety felt lest the caving bank should make a breach in the adjacent levee line. The caving, however, did not extend to the levee, but when the flood subsided the revetment was found to be very seriously damaged. It then appeared that the injury had been caused by the water attacking the upper unpaved portion of the bank, cutting a channel behind the revetment and thus undermining it from the rear. The paving had been originally carried to the elevation of 28 feet on the Greenville gauge, this being then about two-thirds of the flood stage, but the increase of about 5 feet in flood height since 1891 was apparently more than the bank could stand. The revetment was practically destroyed and had to be renewed from about Station 24 to about Station 43, 1,850 linear feet. There was a large hole washed out behind the revetment, Stations 59 to 65, but the channel mat was apparently undisturbed, and the lower portion of the upper bank paving remained intact. The bank was graded down into the hole, filling it up, and the new surface and slope paved to the elevation of 34 feet on the Greenville gauge. The bank paving here aggregated about 1,845 squares.

Minor repairs were also made by regrading and repaving the upper bank and constructing shore mats at Stations 47 to 49 and Stations 140 to 144, where there were slips in the upper bank without apparently disturbing the channel mats. The work was considerably retarded and the cost increased by the difficulty of securing labor and materials on account of the yellow-fever quarantine regulations. The average cost per linear foot of bank was about as follows for the different kinds of work:

New revetment, consisting of standard fascine channel mats and upper-bank paving	$36.86
Refilling and repaving the water hole	26.47
Minor repairs, consisting of shore mats and upper-bank paving	15.87

The work was begun August 23, 1897, and completed January 25, 1898. Additional details are given in the appended report of Assistant Engineer Arthur Hider.

On February 19, 1898, after the subsidence of the January rise, four breaks were discovered in the revetment, two near range 113, one at ranges 4 to 9, and another at ranges 43 to 48. An examination showed that the channel mats had apparently disappeared, permitting deep scour where they had been. These mats were of the woven type built in 1891-92, and it is believed that this old work is all on the eve of disintegration. On March 6 another break appeared about range 12, and again, about March 12, one near range 18. A recent examination (May 11) at about bankfull stage of river indicated that these breaks had enlarged during the April flood, and it is probable that other defects will appear as the water falls.

Without deducting these breaks, which are estimated to aggregate about 2,700 linear feet, the length of revetment in effective condition is about 12,165 feet, measured along the shore edge of the mats. There are also about 2,900 feet of bank protected by the dikes.

The total expenditures for this work have been $698,677.45, not including $42,277.10 contributed by the town of Greenville in 1887.

LAKE PROVIDENCE REACH (517 TO 552 MILES BELOW CAIRO).

Earlier works.—This was one of the reaches first selected by the Mississippi River Commission for systematic treatment. The least low-water depths on its crossings before its improvement was undertaken are variously reported as 4½ and 5 feet. The original project provided for giving the low-water channel an approximately uniform width of 3,000 feet, by constructing contraction works, closing all the chutes, and holding the caving banks. Instead of covering the entire reach of 35 miles, however, as originally intended, the works as built were confined to a reach of about 20 miles, from 522 to 542 miles below Cairo. Operations were begun in 1882 and actively prosecuted until 1885, and some repairs were made to these earlier works in 1886 and 1888-89. The Duncansby, Mayersville, Baleshead, and Stack Island systems of dikes were constructed on the Mississippi side of the channel, and the

Cottonwood and Elton systems on the Louisiana side, and bank revetment was constructed at Louisiana Bend and Mayersville Island. The total lengths of the various constructions were about as follows: 112,396 feet of pile dikes, 48,238 feet of foot mats between dikes, 16,547 feet of foot mats along the dikes, 5,588 feet of screens in front of the dikes, 13,561 feet of wattling between dikes, 520 feet of shore revetment at the ends of dikes, and 33,476 feet of bank revetment. (See Annual Report of 1895, page 3843, for a tabular summary of the work.) The details of these works are given in the Annual Reports of 1883, page 2285; 1884, page 2814, and 1885, pages 2748 and 2960. Maps accompany the reports of 1883, 1884, 1888, and 1889.

These earlier works had a beneficial effect on the channel, but they were comparatively weak and difficult to maintain. The Duncansby system was reported as practically destroyed by 1886, the Louisiana Bend revetment by 1887, and by 1889 only portions of the system at Baleshead Bar and Stack Island remained out of all the works that had been built. Parts of these are still in existence where not exposed to the destructive action of the river.

Louisiana Bend revetment (*522 R*).—In 1889 active work was resumed. It was decided to revet the caving bank near the head of the reach in Louisiana Bend, hoping thus to give greater permanence to the channel throughout the reach. About 6,024 linear feet of revetment were built in 1889–90, 5,224 feet in 1891–92, and 5,835 feet in 1892–93, when further operations were suspended awaiting the results of the experiments with dredging. The type of revetment used was much stronger than that formerly employed, consisting of woven mats below water 260 to 345 feet wide and upper bank paving of stone 10 inches thick. Details of the work are given in the Annual Reports of 1890, page 3229; 1892, page 3177, and 1893, page 3754. A map accompanies each of these reports.

On account of the unstable nature of the bank it was necessary to make some repairs each year to the upper bank paving, where sloughs occurred during low-water stages, and in 1892 and 1893 seven short spur dikes of brush and stone were built on the upper bank, across the mouth of Old River, where the high waters caused scouring behind the revetment. In 1896–97 a break in the revetment at range 126 was repaired by the construction of about 484 linear feet of new revetment, and about 763 feet of revetment were built at the lower end of the work, where about 1,200 feet had been gradually lost by the caving of the bank. After the flood of 1897 a number of breaks appeared between ranges 127 and 156. Provision was made in my project of July 31, 1897, for repairing the only break that was then visible, but later on other breaks appeared, and under date of January 15, 1898, I reported to the president of the commission as follows:

"A survey was made in December, 1897, and three blue prints showing the results of the survey as compared with the surveys of June, 1896, and July, 1897, are forwarded in separate package.

"An examination of these drawings will show that considerable changes were effected during the last high water (and also after the high water at ranges 130 and 131) throughout the greater part of the interval between the new mats sunk in December, 1896. This revetment was built during the low-water season of 1892. The river is very narrow and deep at this point, the width being especially small before the last high water, as shown on the index sheet by the position of the bar line in June, 1896. The last flood enlarged the section, pushing the bar line back, and causing considerable scour through the revetment. When I inspected the work shortly before submitting my project of July 31 for repairs to revetment in the Third district, only the upper break about Range 126 was visible, and provision was made for repairs at this point in case they should appear necessary at a lower stage of water. When the other breaks appeared, a survey was made and it became evident that no effective repairs could be undertaken this year with the plant and money available. To make thorough repairs would practically require the renewal of the revetment from Range 127 to Range 156, a distance of about 2,900 feet, at an estimated cost of about $87,000.

"The available balance for Lake Providence Reach is about $16,000. It seems doubtful whether the benefit to be obtained by maintaining the revetment would justify this additional expenditure, and I, therefore, do not recommend that this broken revetment be repaired, unless it is the policy of the commission to hold the work intact.

"The mattress construction in this portion of the revetment was of the woven type. Fascine mats might prove successful in holding the present bank, which consists of material deposited in the channel of Old River. If the caving be allowed to extend back several hundred feet to the bank of Old River Island, a better foundation for the work would be secured."

No work of construction has been done here during the year, and none is recommended. The length of revetment, including the above breaks, is about 15,820 feet, measured along the shore edge of mats.

Lake Providence revetment (*540 R*).—This revetment was built to hold a rapidly caving bank that threatened to destroy the important levee across the foot of the lake and the town of Lake Providence. About 4,780 linear feet of revetment were built in the season of 1894–95, and 5,360 feet in the following season, 1895–96. The details of the work are given in the Annual Reports of 1895, page 3806, and 1896, page 3653. A map of the work accompanies the report of 1896.

During the past season slight repairs, costing about $822.75, were made to the upper bank paving near the lower end of the work, where some small holes had been washed out near the top of the bank by the flood of 1897. No extension is considered necessary in the near future. The length of revetment in good condition is about 10,090 feet, measured along the shore edge of the mats.

The following table gives the least depths reported on crossings in Lake Providence Reach for the different years:

Date.	Crossing.	Depth on crossing.	Reading of Lake Providence gage.
		Feet.	
1879	Stack Island	5	0.55
1884, Aug. 30	.....do	10	8.9
1885, Oct. 20	Ben Lomond	13	7.1
1886, Sept. 30	Stack Island	8.5	4.7
1887, Sept. 10	.....do	7	4.5
1888, Oct. 23	.....do	9	5.75
1889, Nov. 1	Ajax Bar	7	2.25
1890		11	8.5
1891		7	10
1892, Oct. 23	Ajax Bar	5.5	1
1896, Oct. 30	Wilsons Point	12	1.6
1897, Oct. 11	.....do	7	—2.2

Extreme low-water depths of 6 to 7 feet have been reported for the years 1893–95. The total expenditures for the reach have been $3,534,679.06.

DELTA POINT (598 MILES BELOW CAIRO).

The cut-off that occurred at Vicksburg in 1876, and the subsequent shoaling of the channel leading from the river to the resulting lake front of the city, practically destroyed the harbor of Vicksburg for low-water commerce.

The first operations undertaken for the improvement of the harbor consisted in revetting the rapidly caving bank at Delta Point, as its continued recession was increasing the distance from the harbor proper to the channel of the river. From 1878 to 1881, before the Mississippi River Commission assumed charge of the work, there were built about 5,400 linear feet of revetment, 1 mattress spur dike, and 2 screen dikes, at a total cost of $203,229.87. The details of the work for this earlier period are found in the Annual Reports of 1878, page 637; 1879, page 974; 1880, page 1333; 1881, page 1384; and 1882, page 1502. The river and harbor act of August 2, 1882, placed this work under the supervision of the Mississippi River Commission.

The work of revetment at Delta Point was continued, 1,100 linear feet of revetment being built in the season of 1882–83, 2,200 feet in 1883-84, 2,083 feet in 1884–85, and 1,065 feet in 1893–94. Practically all the work prior to 1882 is destroyed or covered by the later work. Only the mats of 1893–94 have the present standard width of 300 feet, the earlier ones being from 150 to 175 feet wide. Details of the work under the commission are given in the Annual Reports of 1883, page 2290; 1884, page 2820; 1885, pages 2787 and 2964; 1889, page 2709; 1893, page 3754; and 1894, page 2921. Maps accompany the reports of 1883, 1884, 1888, 1889, and 1893.

After the flood of 1897 it was found that the upper bank near the work of 1893, which occupies a salient position, had been attacked somewhat like the upper banks at Greenville and Lake Providence. There was also some caving of the bank above the work of 1893 and a break of the revetment in the pocket below this work, where there is a very strong eddy. Later on there were some slips in the upper bank several hundred feet farther down, about Ranges 6 to 10 E. On August 27, 1897, I submitted a project providing for repairs to the upper bank paving near the work of 1893, and for the extension of this work about 900 feet upstream and about 800 feet downstream. The repairs alone were authorized, and were made from January 21 to 26, 1898, at a cost of about $3,020.28. About 340 squares of the upper bank were graded and paved, using about 1,086 cubic yards of stone.

Much of the revetment at the lower end of the work is covered up by deposit, so that practically the only work remaining that is now exposed to attack is that of 1893, of which apparently about 900 linear feet are in effective condition.

The improvement of Vicksburg Harbor proper is now in charge of the Engineer Department, in accordance with the project adopted by the river and harbor act of

July 13, 1892, providing for the diversion of the Yazoo River into Centennial Lake. A summary of the work done in the harbor by the Mississippi River Commission is given in the Annual Report of 1897, page 3728.

The total expenditures here under the Mississippi River Commission have been $586,234.16, of which about $442,724.77 were applied in Vicksburg Harbor and about $143,509.39 at Delta Point, thus giving total expenditures at Delta Point of about $346,739.26.

LOWER YAZOO LEVEE DISTRICT (365 TO 592 MILES BELOW CAIRO).

This district extends in Mississippi from the Coahoma-Bolivar County line to the mouth of the Yazoo River, being practically coterminous with the local Mississippi Levee district.

The levee line is continuous from the upper end of the district to Eagle Lake. Its length is about 187.1 miles, covering about 215 miles of the river. An extension of the line of about 5½ miles along the north side of Eagle Lake was built by the local levee board in 1886, but has received no attention since then by local or national authorities, until this spring, when a portion of the line was topped up.

The main line contained on May 1, 1897, about 21,911,246 cubic yards of earth, the United States having built about 6,962,600 cubic yards. During the past year there have been added to the line about 4,118,148 cubic yards paid for by the United States, and about 227,463 cubic yards paid for by the local board. The length of line thrown out by crevasses and the construction of new loops was 32,137 feet, containing about 733,421 cubic yards. Tabular statements of expenditures and work done by the United States accompany this report.

The adopted provisional grade for levee work in this district is that of 3 feet above the high water of 1897. It is estimated that about 6,366,000 cubic yards of earthwork will be required to bring the levees to this grade with the standard section, after the completion of existing contracts.

On July 21, 1897, levee work was advertised under the allotments made at the June meeting of the commission. Bids were opened August 11 for about 3,003,000 cubic yards of earthwork in the Lower Yazoo district and about 1,450,600 cubic yards in the Upper Tensas district. Informal proposals were received again August 31 for several pieces of work not awarded or included at the first letting. Bids were accepted in all for about 3,369,000 cubic yards in the Lower Yazoo district and about 1,302,600 cubic yards in the Upper Tensas district, comprising about 40 and 20 contracts in the two districts, respectively. At the date of the last annual report there were 19 incomplete levee contracts in the Lower Yazoo district and 15 in the Upper Tensas district, thus giving in all 59 and 35 contracts in the two districts, respectively. Of these there now remain unfinished 24 contracts in the Lower Yazoo district and 21 in the Upper Tensas district.

On March 22, 1898, I submitted a project for the expenditure of the following preliminary allotments made by the Commission from the funds to be provided by the pending sundry civil bill:

Lower Yazoo district	$260,000
Upper Tensas district	115,000

Authority was obtained to advertise the proposed work, but the advertisement has had to be postponed on account of the April flood.

Levee work was much retarded during the past season by the yellow-fever quarantine regulations that were generally enforced from about the middle of September to the middle of November. These prevented the contractors from organizing forces, and made it difficult and at times impossible to get supplies for forces already organized. After the period of quarantine restrictions there was a brief time when work could be done to advantage, but the months of December and January were marked by excessively heavy rainfall that permitted very little earthwork to be done. While these delays were generally unfortunate, they were especially trying where new loops were being built closing the crevasses of 1897—at Sledges (376 L.), Stokes (380 L.), Stop Landing (434 L.), Deerfield (492 L.), and Shipland (548 L.). In the latter part of January there was a sudden rise in the river that caused considerable uneasiness, as the crevasse loops were still incomplete. It became necessary for the Government and the levee board to put additional forces on the first three of these loops, and they were successfully held against the rising water. At Stop Landing (434 L.) it was necessary to build a protection levee in front of the crevasse, but at the other points the work of construction was confined to the main line.

When the second and greater flood appeared in April, all the crevasse works were complete except that at Stop Landing (434 L). This one was almost finished on March 4, but within the next two days a portion of the levee about 700 feet long cracked longitudinally and the front or river side portion sank several feet, causing an upheaval of the ground in front of the levee. The work of restoring the sunken embankment was begun at once, but the subsidence continued, so that but little was gained in elevation. Work was stopped April 25, when all danger from the April flood was past, the levee board having also, meanwhile, enlarged the protection levee built in January, so that it kept the river from the main line. One of the sections of the sinking levee is shown on the diagram submitted herewith. This section shows successive positions occupied by the original line of intersection with the surface on March 4, on the supposition that each point moved vertically by the measured amount of settlement or upheaval.

Some work has been done during the year in repairing slopes that were wave-washed and gullied by rains, and in cutting weeds to secure better growth of Bermuda grass. Several stretches of low levee below Greenville were topped up in January to grade of 2 feet above high water of 1897, but this kind of work had to be curtailed on account of the extraordinary expenditures required to secure the crevasse loops at Stokes and Stop Landing.

The work of protecting the levees against the flood of 1898 devolved almost wholly upon the State levee board, the Government assisting by furnishing some sacks, lumber, tools, and the use of barges and quarterboats. The flood of 1898 was about 1.6 feet lower than that of 1897 at the upper end of the Third district and about 3.1 feet lower at the lower end (Vicksburg gauge), but at a number of intermediate points it equaled and even exceeded the high water of 1897. This great height made it necessary to undertake considerable work, and I am informed that the high-water fight cost the levee board about $90,000, fully one-third of this amount being required for the protection levee at Stop Landing. The funds in my hands being pledged for other work, the president of the commission on April 5 allotted $10,000 additional to this district, so that I was enabled to render the levee board some assistance. The high-water expenditures in this district were about $5,350.

The accompanying map of overflowed land shows about 654 square miles inundated by backwater at the lower end of the Yazoo Basin.

Additional details of the year's work are given in the appended reports of Mr. J. D. Van Meter and Mr. H. St. L. Coppee, assistant engineers, in charge respectively of the parts of the district above and below Greenville.

The total expenditures by the United States for levees in the Lower Yazoo district have been $2,028,778.56.

UPPER TENSAS LEVEE DISTRICT (402 TO 606 MILES BELOW CAIRO).

This district extends from the Arkansas River to a point in Louisiana opposite Warrentôn, Miss. There is a continuous levee line about 172.1 miles long, extending from Costello's Gin, on Amos Bayou, along that bayou and Cypress Creek to the Mississippi River (13 miles), and thence along the river to the lower end of the district (159.1 miles).

The district is protected from overflow of the Arkansas River by a levee line running along that river from the vicinity of Pine Bluff to the foot of Lake Jefferson. From Pine Bluff to Red Fork this line is of comparatively weak section, built and hitherto maintained by the local authorities. From Red Fork to the foot of Lake Jefferson (12.4 miles), the line was built in 1894–1896 by the United States with the standard section of 8-foot crown and slopes of 1 on 3.

The total yardage in this district May 1, 1897, was about 21,996,612 cubic yards, the United States having built about 15,396,220 cubic yards. During the past year there have been added to the line about 1,403,976.7 cubic yards, paid for by the United States, and about 641,561 cubic yards paid for by the Desha County, Chicot County, Tensas Basin, and Fifth Louisiana levee districts. The length of line thrown out by crevasses and the construction of new loops was 9,066 feet, containing about 330,622 cubic yards. Tabular statements of expenditures and work done by the United States accompany this report.

The adopted grade for levee work in this district is 3 feet above the high water of 1897. It is estimated that it will require about 7,089,000 cubic yards to bring the levees to this grade after the completion of existing contracts.

The letting of contracts for levee work in this district is described above in the report for the Lower Yazoo district. Reference is also made to that report for an account of the general conditions attending levee operations.

The small crevasse in the Amos Bayou line was closed before the January rise of 1898. The Biggs (604 R) and Reed (605 R) crevasses, however, were still open at that time, as they were works of greater magnitude and had been delayed more by the quarantine restrictions and bad weather. At both these places protection levees were built. The one at Biggs held out the January rise, and work was continued on the crevasse loop without interruption. The one at Reed gave way February 4, and caused all work to be suspended there until about the 1st of March. A large force of men was then put on the work and the line was made secure against the April flood. About two-thirds of the Biggs loop was built only to the reduced grade of 1 foot below the high water of 1897, as it became apparent in December that the full-sized levee could not be completed in time to keep out a possible spring flood.

The high-water operations in the Upper Tensas district during the flood of 1898 consisted mainly in topping several low stretches of levee and in guarding the line. A slight additional rise would have increased very largely the amount of work required. All the local organizations cooperated with the Government in the high-water work. As the funds in my hands for this work were very limited, the president of the commission on April 5 allotted $20,000 additional to this district. The expenditures for high-water protection were about $5,019 by the United States and about $5,347.18 by the local levee boards.

The accompanying map of overflowed land shows about 295 square miles inundated by the discharge through the gap between the Arkansas River and Mississippi River systems.

Special attention is invited to the increased caving of the bank at Vaucluse, which is now about 825 feet from the important Whiskey Chute levee across the head of Lake Chicot. The bank is reported to have caved back about 400 feet during the year. At this rate it will soon be necessary to build a new levee across the head of Lake Chicot in a more retired position, or withdraw the line behind Lake Chicot, or revet the caving bank.

Additional details of the year's work are given in the appended reports of Messrs. E. C. Tollinger and W. S. Brown, the assistant engineers in local charge of the levees in Arkansas and Louisiana, respectively.

The total expenditures by the United States for levees in the Upper Tensas district have been $3,377,085.

SURVEYS, GAUGES, AND OBSERVATIONS.

Surveys were made of Carters Neck and Caulks Neck to determine the rate of caving, and complete surveys were made of the different revetments throughout the district in June and July, 1897. Special surveys were made of broken revetments at Ashbrook Neck, Greenville Harbor, and Louisiana Bend. Tracings and blue prints were made showing the results of these surveys. The total expenditures under this heading have been $72,353.66.

STONE.

The reserve supply of stone for repairs to revetment having been about exhausted, and experience having shown that a low-water supply can not be relied upon with certainty, I applied to the commission February 5, 1898, for an additional allotment of $30,000 for stone, to enable me to procure about 30,000 cubic yards from the Little Red River quarries during the high-water season. The allotment was made and a proposal accepted for delivery of stone on Government barges at Bee Rock quarry, Little Red River, at 47.9 cents per cubic yard.

The steamer *Emma Etheridge* was put in commission March 4 for towing stone and the steamer *Vedette* on March 23. The steamer *Titan* and twelve barges were obtained temporarily from the First and Second districts for use in towing stone, and were put in service March 17. The *Vedette* was laid up April 26, as it was found that the other two boats could handle the stone as rapidly as delivered.

During March and April the contractors delivered 11,743 cubic yards on barges at the quarry and 8,155 cubic yards were unloaded on the bank at Greenville.

The total expenditures under this heading have been $154,704.49.

PLANT.

Repairs to plant were made during the year as shown in the detailed statement accompanying the report of Mr. Hider. The principal items were the repairs made to the steamers *Emma Etheridge*, *Vedette*, and *Meter*, replacing rotten timbers that had made it unsafe to keep them in service.

The cost of repairs amounted to $19,636.90, and the cost of caring for the floating plant and other property amounted to $21,438.37.

The commission having allotted $35,000 for a new towboat for the Third district, plans and specifications were prepared, and bids received February 21, 1898. The bid of Mr. Ed. J. Howard, of Jeffersonville, Ind., was the lowest, being $33,850 for the construction of the towboat and $3,600 for the outfit, and it was accepted. The boat is to be a steel hull, stern wheel steamer, length 140 feet, beam 30 feet, with main engines having 18-inch cylinders and 7-foot stroke. The work of construction was begun in April. The total expenditures for plant have been $615,861.59.

The following papers and maps accompany this report:

Report of Mr. Hider on revetment work and plant.

Report of Mr. Van Meter on levees in Mississippi above Greenville.

Report of Mr. Coppee on levees in Mississippi below Greenville.
Report of Mr. Tollinger on levees in Arkansas.
Report of Mr. Brown on levees in Louisiana.
Tabulated labor statements of levee work.
Tables of expenditures by United States for levees.
Map of Third district.
Map of overflowed lands, Third district.
High-water slopes of the Lower Yazoo and Upper Tensas districts.
Diagram showing section of sinking levee at Stop Landing.

The financial statement, list of civilian employees, and abstracts of proposals will be forwarded on or about July 1.

Very respectfully, your obedient servant,

H. C. NEWCOMER,
Captain of Engineers.

COL. G. L. GILLESPIE,
Corps of Engineers, U. S. A.,
President Mississippi River Commission.

REPORT OF MR. ARTHUR HIDER, ASSISTANT ENGINEER.

GREENVILLE, MISS., *May 5, 1898.*

SIR: The following report of construction work, repairs, care of plant, and surveys from May 1, 1897, to May 1, 1898, is respectfully submitted.

Revetments.—No revetment extensions were undertaken during the year, the work done being confined to necessary repairs to the Ashbrook Neck, Greenville Harbor, Lake Providence, and Delta Point revetments.

Repairs to Ashbrook Neck Revetment.—In May, 1897, after the high water had subsided, a slip or cave in the revetment occurred between Stations 83 and 86; two other defects developed later in the season, one between Stations 93 and 96, and the other between Stations 105 and 108. These defects were repaired by constructing shore mats in front and regrading and repaving the upper slope. Work was begun December 13 and finished January 18, 1898. The cost of these repairs amounted to $13,249.53. In order to render this work permanent, extensive repairs will probably be needed the coming season. The most thorough and satisfactory method would be to sink a fascine mat of standard width from Station 96 to the lower end of the work.

Greenville Harbor.—During the high water of 1897 caving occurred from Stations 24 to 42. Between Stations 30 and 35 the upper slope remained intact, except that a channel had been washed behind the revetment. The subaqueous mattress in front of this 300 feet of bank between the breaks in the upper bank above and below did not appear to have been displaced. In front of the breaks above and below soundings show that the mat had been broken up. It was decided to remove the stone from this central 300 feet, regrade the part which projected beyond the shore line above and below, and put in new mattress work from Stations 24 + 50 to 43 + 50, in order to make the bank line more regular.

Between Stations 58 and 65 a large and deep hole was washed out behind the revetment during the high water. This hole was about 550 feet by 200 feet, and at its deepest part 10 feet below low water. The caving at this point evidently began by the current first attacking the exposed part of the upper bank between the top of the stone work and the natural surface of the ground. The bank at this point was nearly vertical and from 6 to 10 feet above the top of the paved revetment. This exposed face of the bank was first eroded and a channel cut behind the revetment, similar to that between Stations 30 and 35, which, as it decreased in depth and width, caused a further undermining and settling of the riprap in front, and an increased caving back of the bank. This revetment was built in 1891. The height of the top of the paved slope was fixed at 28 feet on the gauge (two-thirds stage). The highest water previous to that time was in 1882, 41.7 feet on the Greenville gauge. The height of the flood of 1897 before the levees broke was 46.7, or 5 feet higher.

The entire force of this additional 5 feet of water at flood stage, acting against the nearly vertical face of the exposed upper part of the bank, seems to have been the primary trouble, as this part of the revetment had passed through previous high waters without serious injury. At this particular point is also to be added the effect of the old submerged dikes in contracting the flow and increasing the current between them and the shore. In order to prevent a recurrence of this trouble the revetment from Station 24 to the lower end of the revetment was carried up 6 feet higher than originally built, or to the 34-foot stage. This is practically now the height of the top of the bank, the material above this plane having been removed and used in enlarging the main levee in the rear.

It was estimated that to fill this hole to a slope of one on four, beginning at the 20-foot contour and extending the slope to the 34-foot stage, would require about 62,700 cubic yards of earth. Bids were obtained for doing this work, the lowest bid being 22.54 cents. It was decided to reject all bids, set the main levee further back, and to fill the hole by grading back the bank sufficiently with the hydraulic grader to give a flat grade and cover the exposed bank with riprap, both as being more economical and from the fact that the earth necessary to fill the hole, if the work was done by teams, would have to be procured some distance above and below, and this material was needed for the enlargement of the main levee then under contract.

Another defect in the old work, after the water fell, showed itself between Stations 47 and 49. A small shore mat was sunk in front and the upper bank regraded and repaved. This was thought at the time to be sufficient to protect the work through the next high water, as there was not sufficient money available to make more extensive repairs.

On September 15 a slip occurred in the bank between Stations 140 and 144. An examination showed that the main mattress was uninjured. The bank slipped out bodily, due to the effect of the saturation from the seep water draining through the lower part of the slope. A shore mat was built at this point and the upper bank regraded and repaved.

The rigid quarantine regulations on account of fear of yellow fever, which were in force from September 14 to November 15, interfered materially with the progress of the work and also rendered it more expensive than it would otherwise have been. The restrictions were such as to prevent foreign labor of any kind coming into the town from the county. The local labor was employed in cotton picking, so that it was impossible for the brush contractor to keep up a sufficient supply of material, or for the contractors to deliver stone as required for the needs of the work.

Work was begun August 23, 1897, and finished just in advance of the rising water, January 27, 1898. The cost of these repairs was $88,832.67.

After the subsidence of the high water of February and March, 1898, three defects in the old work showed above Station 24, and one between ranges 42 and 48 above where the pocket mat had been sunk. Later on another slip occurred between Stations 16 and 19, making four breaks in the old work and one just below where the repairs (Stations 24 to 43) had been completed. Soundings in front of these breaks indicated that the subaqueous revetment will have to be renewed. Extensive repairs will be required the present season to this revetment in order to hold the uninjured parts of the revetment intact. The extent of the repairs can not be determined until after the river is again within its banks, but it is probable that the most economical method, in order to make the revetment permanent, will be to sink a line of fascine mats from near the upper end of the revetment down as far as Station 24, and to build a new mat between Stations 42 and 50, regrading and repaving the bank in front of where there are breaks in the upper bank revetment.

Louisiana Bend revetment.—A survey of the revetment, made in December, showed but little change from conditions found in July, except between ranges 130 and 131, where the caving had extended back into the upper bank slope. There are evidences of scour through the mattress from range 140 to range 154, which took place during or immediately after the high water of 1897. At Stations 139 to 140, 146 to 149, 160, and 152 to 156, the bank has cracked, and the subaqueous mat appears to have slid out from the bank. The rest of the revetment at that time was in fair condition. What effect the high water just passed has had on the work can not be determined at present without a survey. Should it be determined to maintain the revetment work in this bend it will probably be necessary to make very extensive repairs to the lower end the coming low-water season. It would be best to sink a mat beginning at Station 127 and extending down to Station 156, a distance of about 3,900 feet, and regrade and repave the breaks in the upper bank revetment.

No work was done, the interruptions due to the quarantine during the months of September, October, and November rendering it impracticable to make any repairs before the high water.

Lake Providence revetment.—No damage was done to this work except that two holes were washed out behind the revetment between Stations 20 and 26. This scour began as that at Greenville, above the top of the stone paving. These two holes were filled with earth, and the slope paving continued so as to cover them. The cost of the work was:

Stone, 375 cubic yards	$573.75
Labor	248.40
	822 75

Delta Point revetment.—The damage done by the high water of 1897 was confined to scour across the point immediately behind the repairs made in 1893 and 1894. Later in the season slipping of the bank below the point occurred. It will be necessary, in order to hold this point, to put in mat work both above and below, and to reslope and repave the steep bank at places. About 1,850 linear feet of revetment will be required, viz, from Stations 4 to 13 east and from Stations 3 + 50 to 13 west.

The repairs made the present season consisted of filling up the hole scoured on both sides of the point and covering the space with riprap. Number of cubic yards of stone used, 1,086.5. The cost of repairs was $3,020.28.

The details of the revetment work for the season, including the statements of quantity of material used, labor cost, towing, etc., are given in the following extract from the report of Mr. George C. Thomas, superintendent of construction:

* * * * * * *

GREENVILLE HARBOR.

Repairs for the season began at Greenville Harbor on August 23 with small force of self-subsisting labor, clearing bank and stripping stone from bank, preparatory to grading. The force was regularly organized and the outfit moved on the work September 1.

Clearing bank.—Under this head is classed all work such as tearing up old revetment, moving drift, rafts, etc., and the grubbing and wheeling back beyond the slope line of all stone not loaded on barges.

Hydraulic grading.—Machine No. 1, with a single crew, one line 4-inch hose, water pressure 145 pounds, steam pressure 180 pounds, was put in service August 24, and worked under above conditions until September 13, when a second crew was put on and machine employed sixteen hours per day until October 2, at which time she was reduced to a single crew, with which she continued the work at this point on November 17, and was temporarily laid up awaiting a transfer to Ashbrook Neck.

Machine was in service seventy-eight days, Sundays excepted, and graded 2,800 linear feet of bank in addition to cutting out the unbroken sections of slope between Stations 32 and 35, and the sloping of 1,000 linear feet of the 5-foot bluff along the top of original work, Stations 52 to 56 and 65 to 71. Bank along continuous work was of pure sand and gullied to about the usual 4 feet. At washout, Stations 59 to 65, the upper bank was of buckshot and cut out to desired slope without gullying.

Slope dressing.—Slope dressing was done with shovels, teams, and drag scrapers. Contract for teams awarded to W. B. Cannon, of Greenville, Miss., at $3.20 per team, including driver.

Total linear feet of slope dressed was 2,550, including the grading of slough between Stations 46 and 50, upon which it was considered impracticable to employ the machine.

Mattress construction.—Mattress construction was begun September 10 and completed December 15.

Number and dimensions of mats constructed.

	Squares.
Channel mat No. 1, continuous work, 525 by 300 feet	1,575
Channel mat No. 2, continuous work, 740 by 300 feet	2,220
Channel mat No. 3, continuous work, 534 by 225 feet	1,201.5
1,799 linear feet	4,996.5
Pocket mat No. 1, continuous work	145
Pocket mat No. 2, continuous work	281
Pocket mat No. 3, continuous work	196.6
Pocket mat No. 4, continuous work	102
Pocket mat No. 5, continuous work	73
Pocket mat No. 6, minor repairs	303
Pocket mat No. 7, minor repairs	273.1
Pocket mat No. 8, minor repairs	78.5
Total squares of mattress built	6,448.7

All mats of fascine type, with no change in plan of construction from that of previous season. Pocket mats constructed from water line to a junction with channel mats; fascines moored to bank.

Bank paving.—Bank paving began October 5, 1897, and was completed January 25, 1898. Amount paved was 7,350 squares. Stone used, 2.81 cubic yards per square. Under instructions from the officer in charge, thickness of paving was reduced from 10 to 6 inches on all work not exposed to the direct action of the current.

Stone loading.—A total of 9,853.4 cubic yards of stone was loaded for this work by the Government force from points as follows:

	Yards.	Per yard.
		Cents.
From breaks in revetment	2,933.4	19.66
From reserve at Greenville	2,442.6	40.72
From reserve at Ashbrook Neck	4,477.4	34.27
Total	9,853.4	

Average cost, 31.63 cents per cubic yard.

Filling washout.—The main bank, beginning at 15 feet, Greenville gauge, was graded to a slope of 4 to 1, and material washed into water hole. Spillways were constructed over secondary bank between water hole and river, to regulate the height of water in pond and prevent the destruction of this bank from overflow. The grading completed, the water was drawn off, and the filling completed by means of shovels and drag scrapers. Material for the purpose was obtained from secondary bank and from main bank at each end of water hole. Grading began October 20 and was completed November 17. Water was then drawn off and the fill by material from main bank was found to have attained an average elevation of 10 feet, Greenville gauge, a maximum fill of 20 feet at center of hole. Shovels and scrapers were introduced on November 17, and the work was completed on December 18. The cost of the work will be found in detailed statements appended hereto.

Material.—Brush and poles were furnished under contract by F. O. Reinhold, delivered on Government barges at Carters Point, Ashbrook Neck, Island No. 76, Caulks Point, Rosedale Bar, and old mouth of Arkansas River.

Stone furnished under contract by Tate & Cornish, delivered on barges at Greenville, Miss.; by Fred Hanger, delivered on barges at Arkansas City, Ark., and from the reserves at Greenville and Ashbrook Neck, loaded by Government force.

Quarantine restrictions, prohibiting the importation of labor, seriously interfered with the delivery of material up to November 15.

Towing and harbor work.—The tug *Parker* was employed from the beginning of the season until October 24 in towing brush and in general harbor work. For remainder of season her duties were confined to harbor work and towing stone from plant to harbor. The *Vedette* was put in service October 24 and employed towing brush until December 1, at which time she was returned to plant and crew transferred to steamer *Emma Etheridge*. The *Etheridge* was in service until the close of the season, February 1, 1898, and then transferred to plant.

The work at Greenville Harbor was completed on January 25, and cost as follows:

For continuous work	per linear foot	$36.86
For minor repairs	do	15.8727
For filling and paving water hole	do	26.4717

Distribution of material.

[Continuous work.—1,850 linear feet.]

Material.		Quantity.	Per linear foot.
Brush	cords	7,800.5	3.94
Poles	do	252	.136
Stone	cubic yards	18,863.4	10.2
Wire strand, ⅝-inch	pounds	11,930	6.45
Wire strand, ⅜-inch	do	3,600	1.95
Wire strand, 5/16-inch	do	21,203	11.46
Wire strand, ¼-inch	do	36,095	19.51
Galvanized wire, No. 12	do	19,530	15.57
Silicon bronze wire	do	6,199.4	3.35
Wire spikes	do	500	.27
Wire staples	do	823	.44
Magnolia clips	number	4,258	2.30

Distribution of material—Continued.

[Channel mattress.—4,996.5 squares.]

Material.	Quantity.	Per square.
Brush ....cords..	6,295.5	1.26
Poles........do....	221	.044
Stone ....cubic yards..	5,096.4	1.02
Wire strand, ⅝-inch ....pounds..	11,930	2.39
Wire strand, ⅜-inch ....do....	3,600	.72
Wire strand, 5/16-inch ....do....	18,287	3.66
Wire strand, ¼-inch ....do....	31,118	6.24
Magnolia clips........number..	4,258	.85
Wire spikes........pounds..	500	.10
Wire staples ....do....	699	.14

[Pocket mat (fascine type).—797.6 squares.]

Material.	Quantity.	Per square.
Brush ....cords..	1,005	1.26
Poles........do....	31	.039
Stone........cubic yards..	813	1.02
Wire strand, 5/16-inch ....pounds..	2,919	3.66
Wire strand, ¼-inch ....do....	4,977	6.24
Galvanized wire, No. 12 ....do....	2,042	2.56
Silicon bronze wire........do....	853.4	1.07
Staples........do....	100	1.25

[Paving bank.—4,605 squares.]

Material.	Quantity.	Per square.
Stone ....cubic yards..	12,954	2.813

Minor repairs to original revetment.

[Pocket mats.—654.6 squares.]

Material.	Quantity.	Per square.
Brush ....cords..	843.8	1.26
Poles ....do....	26.2	.039
Stone ....cubic yards..	668	1.02
Wire strand, 5/16-inch ....pounds..	2,374	3.66
Wire strand, ¼-inch ....do....	4,146	6.24
Galvanized wire, No. 12 ....do....	1,670	2.56
Silicon bronze wire........do....	700.6	1.07
Staples........do....	81	.125

[Bank paving.—900 squares.]

Material.	Quantity.	Per square.
Stone ....cubic yards..	2,532	2.813

Water hole.

[Bank paved.—1,845 squares.]

Material.	Quantity.	Per square.
Stone ....cubic yards..	5,193.62	2.813

Cost per unit of work done.

CONTINUOUS WORK.

Classification.	Units.	Pay roll.	Subsistence.	Material.	Total.	Unit cost labor.	Unit cost material.	Total cost per unit.
Channel mat...squares..	499.65	$5,262.97	$677.57	$16,998.05	$22,938.59	$1.189	$3.424	$4.613
Pocket mat.........do....	797.6	700.93	90.70	2,545.44	3,337.07	.993	3.191	4.184
Hydraulic grading, linear feet....................	1,900	1,249.68	187.50	170.55	1,607.73	.7564	.0897	.8461
Dressing grade...lin. ft..	1,900	2,299.04	217.76	....	2,516.80	1.324	....	1.324
Loading stone:								
Old work ...cu. yds..	2,993.4	519.47	66.75	....	586.22	.1966	....	.1966
Plant..........do....	2,442.6	986.99	8.59	....	995.58	.4072	....	.4072
Ashbrool Neck, cubic yards..............	4,477.4	1,336.94	197.43	....	1,534.37	.3427	....	.3427
Paving bank...squares..	4,605	4,132.27	531.00	19,934.06	24,597.33	1.013	4.3266	5.3392
Clearing bank.....do....	....	691.01	88.80	....	779.81	....	....	....
Care plant............	....	1,314.90	168.97	....	1,483.87	....	....	....
Superintendence.........	....	2,306.70	142.25	....	2,448.95	....	....	....
Miscellaneous, Memphis office..................	....	1,550.00	....	737.14	2,287.14	....	....	....
Towing..................	....	1,859.71	399.81	824.81	3,084.33	....	....	....
Total............	....	24,210.61	2,777.13	41,210.05	68,197.79	....	....	....

Cost per linear foot completed work: $68,197.79 divided by 1,850 equals $36.86 per linear foot.

MINOR REPAIRS.

Classification.	Units.	Pay roll.	Subsistence.	Material.	Total.	Unit cost labor.	Unit cost material.	Total cost per unit.
Pocket mat....squares..	654.6	$660.40	$84.86	$2,153.88	$2,899.14	$1.015	$3.2902	$4.3057
Paving bank......do....	900	787.36	101.13	....	888.49	.9872	....	.9872
Grading complete	300	500.32	55.28	52.12	607.72	1.852	.1737	2.0257
Grading upper slope.....	1,000	258.80	37.60	70.08	366.48	.2964	.0708	.3664
Total............	....	2,206.88	278.87	2,276.08	4,761.83	....	....	....

WATER HOLE.

Classification.	Units.	Pay roll.	Subsistence.	Material.	Total.	Unit cost labor.	Unit cost material.	Total cost per unit.
Clearing bank....lin. ft..	600	$206.17	$26.49	....	$232.66	3.894	....	3.894
Filling water hole.do....	600	1,440.81	89.33	....	1,530.14	2.5502	....	2.5502
Hydraulic grading.do....	600	688.75	109.17	$182.14	980.06	1.33	0.3036	1.6334
Paving bank...squares..	1,845	1,613.42	207.82	7,790.43	9,611.17	1.987	4.224	5.201
Memphis office...........	....	625.00	....	86.34	711.34	....	....	....
Property purchased	....	....	....	209.17	209.17	....	....	....
Towing..................	....	1,212.64	163.71	354.75	1,731.10	....	....	....
Superintendence.........	....	745.17	71.13	....	816.30	....	....	....
Miscellaneous	....	....	....	61.11	61.11	....	....	....
Total............	....	6,531.96	667.15	8,683.94	15,883.05	....	....	....

Average cost per linear foot, $26.47.

Percentage of cost of the various items of work.

Items.	Charge.	Per cent.
Pay roll (including team hire)........................	$30,774.45	33.427
Subsistence..................................	3,723.15	4.293
Materials..................................	51,273.54	58.647
Property..................................	627.50	.709
Memphis office..................................	2,484.08	2.924
Total..................................	88,882.67	100

ASHBROOK NECK.

Work began on December 13, the outfit having previously been transferred to this point December 5 to load stone for Greenville Harbor.

Repairs consisted in the construction of four small pocket mats and the grading and paving of 1,130.2 squares of upper bank work.

Mattress construction.—Mattress construction began December 13, and the last mat was sunk on January 7. Mats built in advance of grading, and method of construction similar to pocket mats at Greenville. Number and dimensions as follows:

	Squares.
No. 1, stations 83 to 86	248
No. 2, stations 93 to 96	199
No. 3, stations 105 to 108	159
No. 4, supplementary to No. 3	151
Total	757

Caving occurred behind mat No. 3 while bank was being graded, which necessitated the construction of mat No. 4 to complete the connection at that point.

Clearing bank.—One hundred and fifty cubic yards of stone wheeled back beyond slope line and 87 squares of old brush revetment torn up to prepare bank for grading.

Hydraulic grading.—Hydraulic grading began on December 11, and was completed January 18. Amount graded, 690 linear feet, machine working under same conditions as at Greenville Harbor with single crew.

Slope dressing.—Slope dressing was done by means of shovels; 990 feet were dressed, which includes unsloping on bank between stations 105 and 108 when machine was not employed.

Bank paving.—Bank paving began December 29 and was completed January 18. Amount paved, 1,130.2 squares. Stone per square, 2.68 yards.

Stone loading.—There were 698.1 cubic yards of stone stripped from breaks in old work and 3,094 cubic yards loaded from reserve on bank.

Material.—Brush and poles transferred from Greenville Harbor, excepting 204 cords of brush cut by Government force for the construction of mat No. 4.

Stone from breaks in old work and reserve on bank loaded by Government force.

Distribution of material.

[Pocket mats.—757 squares.]

Material.	Quantity.	Per square.
Brush used....cords..	920.7	1.22
Poles....do....	50	.66
Stone....cubic yards..	760	1.00
		Per lb.
Wire strand, $\frac{5}{16}$-inch....pounds..	3,130	4.13
Wire strand, $\frac{1}{4}$-inch....do....	3,868	5.11
Galvanized wire, No. 12....do....	1,300	1.72
Silicon bronze wire....do....	1,000	1.32
Spikes....do....	100	.13
Staples....number..	45	.06

[Bank paving.—1,130.2 squares.]

Stone used....cubic yards..	3,032.41	2.68

Cost per unit of the various kinds of work.

Classification.	Units.	Pay roll.	Subsistence.	Miscellaneous and material.	Total.	Unit cost labor.	Unit cost material.	Total cost per unit.
Pocket mat.....squares..	757	$1,299.88	$421.06	$2,062.01	$3,782.95	2.273	2.424	4.697
Bank paving.......do....	1,130.7	734.00	237.76	2,920.30	3,892.06	.86	2.32	3.18
Loading stone...cu. yds..	3,094.3	924.07	236.06	....	1,160.13	37.453	1.77	.37453
Hydraulic grading.lin.ft..	990	272.17	53.02	175.25	500.44	32.85	....	.555
Dressing slope.....do....	990	345.47	111.96	....	457.43	46.2	....	.462
Towing days............	48	727.25	125.76	900.73	1,753.74	....	....	....
Memphis office..........	....	705.00	....	78.38	783.38	....	....	....
Miscellaneous..........	....	....	....	25.56	25.56	....	....	....
Superintendence........	....	360.00	88.64	....	448.64	....	....	....
Clearing bank..........	....	336.28	108.92	....	445.20	....	....	....
Total..............	....	5,704.12	1,383.18	6,162.23	13,249.53	....	....	....

Percentage of cost of the different items of work.

Items.	Charge.	Per cent.
Pay roll	$4,999.12	37.73
Subsistence	1,383.18	10.40
Materials	6,083.85	45.78
Memphis office	783.38	6.00
Total	13,249.53	100

DELTA POINT.

The work at Ashbrook Neck was completed on January 18, and the outfit transferred to Delta Point, where operations were begun on January 21 to check the scour behind the repairs, work of 1894.

The sides of the cut were reduced to a slope of 3 to 1 and the entire surface of scour covered with a stone paving 10 inches thick, stone for the purpose being transferred from Greenville Harbor.

The work was completed on January 26, and the outfit transferred to plant at Greenville on January 29.

Thanking my assistants for efficient service,

I am, respectfully,

GEO. C. THOMAS, *Superintendent.*

Surveys.—Survey of Carters Neck and Caulks Point, also over the revetments at Bolivar, Ashbrook Neck, Greenville Harbor, Louisiana Bend, Lake Providence, and Delta, have been made, plotted, and maps made.

Stone.—The steamer *Emma Etheridge* was put in commission on March 4, and towing stone from the quarries on Little Red River was begun. The steamer *Titan* with twelve barges was obtained for temporary service, from the first and second districts, and was put in service on March 17.

On account of a breakdown in the machinery of the steamer *Emma Etheridge*, the *Vedette* was put in service on March 23, but was withdrawn on April 26, as the contractors were unable to load stone with sufficient rapidity to keep the three towboats profitably employed.

The contractors have quarried and loaded on barges up to May 1, 11,743 cubic yards. The stone is being towed to Greenville and unloaded on the bank as a reserve; 8,155 cubic yards have been unloaded, at a cost of $802.31, or an average cost of 9.84 cents per cubic yard.

High-water levee protection.—At the beginning of the year there were still in this service three quarter boats and three barges. During the high water of January and February, 1898, outfits of tools were furnished for Stokes, Sledges, Stop, and Deerfield crevasses, in Mississippi, and at Luna and Leland, in Arkansas. Three quarter boats were taken to Carmichael, Ark., two quarter boats to Waxhaw, Miss., and two quarter boats to Stop Landing, Miss. During the high water of April, 1898, outfits of tools and quarter boats were sent to Stop Landing and Deerfield, Miss.; also to Lucca Landing, Ark., and barges with material sent to Kentucky Landing, Stop Landing, Lucca Landing, Skipwith, Deerfield, Luna, Lakeport, and Lake Providence.

Plant.—Extensive repairs were made to the hulls of three towboats (*Emma Etheridge*, *Vedette*, and *Meter*). All defective timbers were removed from their hulls, and replaced with new material. This practically nearly amounted to reconstruction, as the greater number of the frames, floors, and deck beams were rotten, as well as the sides, bow, and stern planking. The work done in the way of repairs, and the cost of same is given in detailed statement below. This includes all charges for labor and material.

As instructed, plans and specifications were prepared for a steel-hull towboat. This boat has about 40 per cent more power than the steamer *Emma Etheridge*, the largest towboat belonging to the Third district. The boat is now being built under contract. The general dimensions are: Length, 140 feet; beam, 30 feet; depth of hold, 5½ feet; main engine cylinders, 18 inches diameter, 7-foot stroke; four 5-flue boilers, 42 inches in diameter and 26 feet long; wheel 20 feet in diameter, 21-foot bucket, electric lights, auxiliary boiler, steam steering and shifting rigging.

Cost of repairs to plant, Third district, improving Mississippi River, May 1, 1897, to May 1, 1898.

Number or name.	Cost.	Remarks.
Steamer—		
Emma Etheridge	$3,864.31	Docked; new cylinder timbers; 37 outriggers; 48 frames; 24 beams; 50 carlins; 10 kevils; head block; stern bulkhead; yawl derrick; railing on roof; boilers repaired and recovered; hull calked and boat thoroughly repaired and painted; ordinary repairs during the year.
Vedette	3,926.40	Docked; new cylinder timbers; 60 new frames; 50 outriggers; new side plank; 20 floor timbers; new bed timbers; new main keelson; machinery overhauled; hull calked; boat thoroughly repaired and painted; ordinary repairs during the year.
Meter	3,237.88	Docked; all rotten and decayed lumber taken out; new floor timbers; 40 new frames; new main and wing keelson; new outriggers; new sides; machinery overhauled; hull calked; boat thoroughly repaired and painted; ordinary repairs made during the year.
Titan	180.27	Wheel and electric light repaired.
Tug Parker	732.69	New wheel put on; machinery lined up; ordinary repairs during the year.
Grader—		
No. 1	124.30	Calked above light water; machinery overhauled and fitted up and cleaned.
No. 3	9.96	Machinery cleaned up.
Mattress boat—		
No. 26	60.02	Calked above light water; ordinary repairs made during the year.
No. 27	61.00	Do.
Quarter boat—		
No. 17	29.13	Ordinary repairs made during year.
No. 19	48.72	Calked above light water; ordinary repairs made during year.
No. 31	220.50	Do.
No. 38	60.81	Do.
No. 86	41.57	Do.
No. 87	21.98	Ordinary repairs during year.
No. 88	27.72	Do.
No. 136	53.90	Calked above light water; ordinary repairs made during year.
No. 154	65.25	Do.
No. 155	49.90	Do.
No. 156	197.26	New roof put on; calked above light water; ordinary repairs during year.
No. 157	38.80	Calked above light water; ordinary repairs during year.
No. 158	68.38	Do.
No. 159	85.99	Do.
Model barge—		
Apache	100.63	Do.
Cheyenne	163.23	Calked above light water; ordinary repairs during the year.
Maricopa	2.90	Lower seam calked.
Nez Perce	151.15	Calked above light water; ordinary repairs during the year.
Barge—		
No. 79	47.51	Do.
No. 80	6.75	Ordinary repairs during the year.
No. 83	61.02	Calked above light water; ordinary repairs during year.
No. 85	15.88	Ordinary repairs during year.
No. 106	55.77	Calked above light water; ordinary repairs during year.
No. 137	8.75	Ordinary repairs during year.
No. 530	9.75	Do.
No. 551	99.58	Calked above light water; ordinary repairs during year.
No. 552	105.23	Do.
No. 553	66.17	Do.
No. 554	200.20	Docked; hole in rakes repaired; calked above light water; ordinary repairs during year.
No. 555	181.91	Do.
No. 556	72.23	Calked above light water; ordinary repairs during year.
No. 557	139.82	Docked; hole in rake repaired; calked above light water; ordinary repairs during year.
No. 558	106.05	Calked above light water; ordinary repairs during year.
No. 559	50.73	Do.
No. 560	59.51	Do.
No. 561	29.98	Do.
No. 562	60.48	Do.
No. 563	53.28	Do.
No. 564	76.70	Do.
No. 565	68.09	Do.
No. 210	451.53	Deck sheathed; hole in side repaired; calked above light water; ordinary repairs during year.
No. 216	150.54	Deck sheathed; calked above light water; minor repairs.
No. 217	211.74	Deck sheathed; sides repaired; calked above light water; ordinary repairs during year.

Cost of repairs to plant, Third district, improving Mississippi River, etc.—Continued.

Number or name.	Cost.	Remarks.
Barge—Continued.		
No. 220	$247.74	Deck sheathed; calked above light water; ordinary repairs during year.
No. 224	479.09	Deck sheathed; sides repaired; calked above light water; ordinary repairs during year.
No. 225	70.56	Calked above light water; ordinary repairs during year.
No. 226	237.14	Deck sheathed; calked above light water; ordinary repairs during year.
No. 111	19.75	Calked above light water; ordinary repairs during year.
No. 9302	17.70	Calked above light water.
No. 9308	23.24	Do.
No. 9318	66.00	Do.
No. 9314	30.00	Do.
No. 9315	4.00	Ordinary repairs.
Machine shop	139.89	Machinery lined up; calked above light water; ordinary repairs during year.
Carpenter shop	36.58	Calked above light water; ordinary repairs during year.
Pile driver No. 49	49.52	Do.
Dry dock	330.88	Gate repaired; new bulkhead around belt; tanks calked; ordinary repairs during year.
Pontoon dock	20.48	Ten new beams; new deck timbers; calked above light water.
Coal boxes	69.48	Ordinary repairs during year.
Water gauges	31.45	150 high-water gauges made and painted.
Pumps	252.61	Ordinary repairs during year.
Skiffs	122.68	Ordinary repairs to 20 skiffs during year.
Wheelbarrows	169.80	Ordinary repairs to 200 wheelbarrows during year.
Property (kitchen outfit)	526.37	Ordinary repairs during year.
Property (Greenville Harbor tools, etc.).	494.15	1,000 clevises made; ordinary repairs during year.
Bench marks (levees)	113.99	Ordinary repairs during year.
Telephones	10.50	Do.
Total	19,636.90	

Approximate value of plant belonging to the United States and used in the Third district, improving Mississippi River, May 1, 1897, to May 1, 1898.

Class of property.	Number.	Approximate value.	Class of property.	Number.	Approximate value.
Steamer Emma Etheridge	1	$7,500	Floating dry dock	1	$11,529
Steamer Vedette	1	5,000	Floating pontoon docks	2	450
Steamer Meter	1	4,000	Floating stern dock	1	100
Tug Parker	1	3,000	Pile drivers and outfits	2	1,600
Mat boats Nos. 26 and 27	2	7,290	Skiffs	26	390
Mat boats, old	2	30	Dredge Menge	1	9,000
Headquarter boat No. 31	1	4,500	Dump scow No. 2	1	100
Quarter boats	14	20,140	Calking flats	3	90
Store boat	1	1,000	Tools and appliances	......	2,000
Hydraulic graders	2	11,664	Office furniture and safe	......	250
Hydraulic grader, small	1	810	Surveying instruments	......	2,000
Model barges	5	250	Machine shop and outfit	1	4,050
Square barges	11	2,245	Carpenter shop and outfit	1	2,916
Do	21	21,240			
Square barges, old	5	250	Total	109	143,599

The cost for the twelve months of caring for the above plant, property, and outfits thereon was $21,438.37.

The average number of employees engaged in the service was 48.

The average daily cost of subsistence for employees engaged in superintendence and repairs of plant was 32 cents.

Very respectfully,

ARTHUR HIDER,
Assistant Engineer.

Capt. H. C. NEWCOMER,
Corps of Engineers, U. S. A.

REPORT OF MR. J. D. VAN METER, ASSISTANT ENGINEER.

GREENVILLE, MISS., *May 7, 1898.*

SIR: I have the honor to submit a report of levee improvement in the Lower Yazoo district north of Greenville, Miss., from May 1, 1897, to May 1, 1898.

The length of controlling levee line in this subdistrict is about 88.5 miles, which is an increased length of 1½ miles over last report. This increase in length is due to new loops closing crevasses of last season. New levees now under construction will shorten the line about 8 miles.

The three breaks occasioned by the 1897 water have been closed, and all then existing enlargement contracts finished except from Stations 300 to 400 and Stations 500 to 600, which show a percentage in place of 71 and 89 per cent, respectively. Forces are on both sections awaiting the recession of the water to begin work.

The Mississippi State levee board has added 143,675 cubic yards to the line north of Greenville within the last year. This yardage is comprised in the construction of the two short loops, one in Greenville and the other just outside of the northern limit of the town, and the building of 1,400 feet of the loop closing the Stokes crevasse on the lower end. There is also included in the above item of yardage 21,200 cubic yards of topping extending over 9 miles of line, and put up recently as a protection against high water of 1898. The location of the levee board work is:

	Stations.
Stokes loop	1050 to 1064
Blanton loop	4502 to 4520
Greenville loop	4560 to 4569

The high water of 1897, being so much higher than any previous water, changed the grade for levee building from 5 feet above the previous highest water to 3 feet above 1897. This change was essential for the upper portion of the line from zero to Station 600, then under contract for enlargement. Accordingly the grade was raised, and an enlargement on the land side instituted in the form of a banquette from Stations 100 to 595 and from Stations 618 to 657, the intervening space being covered by the new loop closing the Sledge crevasse of 1897. The water was relatively very much higher from zero to Station 700, owing to the levee on the opposite bank having been extended to a junction with the Laconia Circle levee confining the flood between levees that previously had been allowed to spread over a broad territory. The raising of the grade and addition of the banquette very materially increased the yardage in the contracts over original estimates and explains the excess over advertised quantities to which bids were invited and on which contracts were made. From Station 700 (Concord) south, the grade was not changed for existing contracts, as the adopted grade to which cross-sectioning had been done, 5 feet above 1890 water, very nearly conformed to the new grade, 3 feet above 1897 water.

August 11, 1897, bids were received and contracts let for closing Stokes and Stop Landing crevasses, the building of the Huntington Short Line, and the enlargement of the levee, as follows:

Stations 2620 to 2880.
Stations 2959 to 3186.
Stations 3225 to 3282.
Stations 3880 to 3930.
Stations 4150 to 4570.

August 31, 1897, bids were received for closing the Sledge crevasse, and the enlargement of the levee, Stations 1037 to 1200.

On bids received in August, twenty-nine contracts were made for enlargement and new levee.

There are also to be considered in this report contracts made on bids received November 23, 1896, none of which contracts were finished before May 1, 1897. Of these contracts there were nineteen, all for enlargement of levees, that covered the line from zero to Station 1,000 and from Stations 1,200 to 2,066.

The number of contracts considered in this report is forty-eight, aggregating 63.5 miles in length. At the time of report thirty of these contracts have been finished and final estimates given.

The general conditions affecting levee work for the past year may be regarded as very unfavorable for progress and rapid completion. The heat is so intense during the summer months that great loss of time is occasioned, as teams can only be worked early and late in the day. The fall months constitute the period of greatest advantage to contractors. A rigid quarantine against yellow fever was established and in force in Bolivar County from September 13 to November 11, 1897, and in Washington County from September 14 to November 15, 1897. The quarantine restrictions greatly hampered the progress of work, owing to the inability to import labor or to move outfits.

The rainfall for December was exceptional, being 9.12 inches, which is about twice greater than the mean for the past twelve years for December at this station. The river reached an unusual height in February—43.1 on the Helena gauge. This stage of the river suspended all riverside enlargement from January 24 to February 25 and necessitated very strenuous efforts in finishing crevasse loops at Sledge, Stokes, and Stops. The second rise, of March and April, has suspended all work except where protected by outside levees.

Crevasse loops and new levees.—Contract was made with H. F. Watkins, on a bid opened August 31, 1897, for a new levee in two sections, closing the Sledge Crevasse of 1897. This new loop begins with Station 595, carrying a regular enumeration to Station 641+20, equal to 618, original enumeration. By this crevasse and new loop there is a loss of 500 feet to E. B. Mantle's enlargement contract, Stations 500 to 600, and also a loss of 1,800 feet to L. C. Dulaney's original contract, Stations 600 to 700. Work was begun on the Sledge loop September 16, 1897, and completed February 19, 1898. Work progressed fairly well until the unfavorable weather of December. The lower section, Stations 625 to 641+20, was completed November 24.

It became apparent toward the last of December that the force employed on the upper section of Sledge loop, Stations 595 to 625, would be insufficient to complete the contract in contract time, February 1. Accordingly the contractor was instructed to increase his force, which he did to some extent. The bad weather continued so unabatingly through the first half of January, with the river rapidly approaching an overflow stage, that it was considered advisable to place additional team force on at contractor's expense. The levee board extended the consideration of placing a wheelbarrow force on the work at no expense to the contractor. By January 28 a force of 111 teams and 220 wheelbarrows was employed. On February 1 the wheelbarrow force was taken off and team force reduced to 90 teams, it then being apparent that such a force could complete the work before the possibility of a dangerously high water.

Stokes loop.—The closing of the Stokes Crevasse was begun as soon as the water had receded sufficiently to permit of a force beginning work. There was some apprehension of a June rise flowing through the break, and the levee board considered it advisable to build a levee of moderate height around the break as a precautionary measure. Accordingly, before the water had ceased to flow through the crevasse a contract was let for a levee from 6 to 8 feet high, and to contain between 30,000 and 40,000 cubic yards. Before the contractor could begin work such a levee was considered unnecessary and the project abandoned, giving the contractor 45,789 cubic yards in standard section on permanent location, this being contained in 1,400 feet of the new loop from the south junction.

W. A. Shippey's contract, Stations 900 to 1000, sustained a loss of 700 feet of enlargement by the break and consequent new loop; accordingly six stations of the new loop were given to the contractor, making Shippey's contract end at Station 999. The remaining portion of the new location was divided into three sections: Stations 999 to 1018, Stations 1018 to 1034, and Stations 1034 to 1051^a. Contract was made with McIntyre & Howard for the three sections, on bids opened on August 11, 1897. Work was begun September 6; by November 15 there were 44 teams on the work, and December 1, 54 teams. On December 21 contractor was instructed to increase the force to 200 teams by January 3, there then being 86 teams employed. The local levee board, however, intervened to relieve the contractor of what would have been a great burden of expense by placing 44 teams on the work about January 1 at no expense to the contractor. This expense on the part of the Board was assumed as a relief measure, offsetting as much as practicable the hardship sustained by contractor through the quarantine restrictions, in force from September 13 to November 11. On January 3 there was a force of 181 teams employed, practically covering the line wherever teams could be worked to any advantage.

The weather continued rainy until the last week in January, the river rising and coming out against the new work, and the ground being saturated with seep water from Stations 1018 to 1032. The base of this portion of the line only was in, and it was impracticable to work teams on this gap except on 300 feet from Stations 1018 to 1030 and 200 feet from Stations 1030 to 1032. The supply of material being cut off by water on the river side, it became necessary to resort to the land side. By January 20 it was clearly evident that teams could not finish the gap from Stations 1021 to 1030, in consequence of seepage and rain water having cut off the supply of material. Ditching and organization of a wheelbarrow force was begun on January 24, and by the last of the month 180 wheelbarrows were running, keeping the bank uniformly above the rising water. The levee board volunteered the expense of the wheelbarrow force from its organization (January 24) to February 3, when the United States took charge of it without expense to contractor, team force working wherever practicable. Wheelbarrow force was discharged February 25.

The Stokes loop, Stations 999–1051^a (3 sections), was finished March 1. A deduction of 9,807 cubic yards was made from contractors' final estimate on middle section of Stokes loop, this being the estimated yardage placed by wheelbarrow force between February 3 and 25, when the United States assumed the expense of wheelbarrow force, the cost of same being $5,106.40. The expense assumed by the Mississippi levee board to the relief of contractor on middle section, Stokes loop, Stations 1018 to 1034, is as follows:

Team hire, January and February	$7,053.20
Wheelbarrow force, January and February	1,937.91

There are other items of expense sustained by the levee board for outfit, lumber, and subsistence.

Stop Landing loop.—Contract was made with Robert Johnsen, on a bid opened August 11, 1897, for the building of a levee 5,348 feet in length, divided into three sections, as follows:

Stations 3187 to 3201.
Stations 3201 to 3215.
Stations 3215 to 3239^a.

Contractor's outfit was moved to site of new loop August 12 and work was begun on the lower section August 16. An average force of about 70 teams was maintained on the work of the contractor's own force, except during the quarantine period, September 13 to November 11, when the force was considerably less, owing to inability to secure labor. The location here is back of what was originally the site of the old levee, and crosses a depression 1,000 feet wide, evidently the silted-up bed of Lake Bolivar. The fill across this depression ranges from 22 to 25 feet to attain a grade of 3 feet above high water of 1897. The crossing of this depression is unavoidable for any line closing the break, and the one adopted presents the shortest and highest ground obtainable in accordance with estimates for material, there being a water hole 300 feet to the front, the result of the scour through the break. This hole has maintained almost a bank-full stage of water since the break. An attempt was made to drain it into a larger hole that is very much influenced by the stage of the river. Through ditching and pumping the water was lowered possibly 3 feet, and this might have proven very beneficial in relieving the borrow pits of water, except for the continued rains in December and January keeping the material continually saturated, and as the supply on the front became exhausted it was necessary to resort to the land side, and even there the haul soon lengthened to 1,000 feet. The upper and lower sections were practically finished by the contractor, hired teams assisting a few days on the upper section. The real trouble and delay existed in the middle section, this being cut off from the material on the front, and necessitating a long haul from the back.

Contractor was instructed on December 21 to increase force to 200 teams by January 3, there then being employed on the work about 70 teams. By the middle of January the necessity for concentration of force from neighboring contracts became very manifest, as the heaviest part of the work with the longest haul remained to be done, there then being little more than the base in from Stations 3202 to 3209. Hired force was placed on the work to the extent of 165 teams. Even with this force the levee did not build up rapidly, and with a rising river almost to a bank-full stage it was deemed advisable to throw up a temporary protection levee on the front. Accordingly, all forces were moved to the front and employed on a protection levee starting at a point some distance above the break and following high ground along the river bank and connecting with the main levee some distance below the break. This work was begun on January 18 and suspended January 31, at which time a levee had been built 7,548 feet in length, to a grade 5 feet below high water of 1897, sufficient for the January rise. The protection levee contained about 45,180 cubic yards, at a cost of $8,606.75. Hired forces were again employed on the interior line February 1, and maintained until March 9, when the last of the hired forces were discharged. On March 4 it was estimated that there remained 2,300 yards to finish the loop, this being required between Stations 3202 and 3210.

At this time the embankment began to sink from Stations 3203 to 3210, which is about the length of the old lake crossing. The sinking did not involve the whole cross section at first, its limits being clearly defined, breaking somewhat to the land side of the center and settling toward the front, bulging or raising the surface of the ground outside the limit of the front slope. This raising of the surface is noted 150 feet beyond the slope. A force of from 70 to 72 teams was kept constantly at work on the sinking portion of the levee from March 4 to April 25, when work was suspended. Cross sectioning then showed that it would require 8,250 cubic yards to bring the sunken portion up to net grade as it then stood. As work continued after March 4, the whole cross section became involved, and raising of the surface outside the base on the back took place as well as on the front, though not so pronounced. It is estimated that 29,000 cubic yards of material have been placed in this sunken portion from March 4 to April 25, and yet the cross section shows 6,000 cubic yards more to attain net grade than when the sinking began. It is also estimated that

25,000 cubic yards of the displaced material is in evidence outside the limits of the slope. The estimate of displaced material is for such as is now shown above the normal surface of the ground. The contract for this work was terminated March 11, relieving the contractor of the responsibility of the work after that date. From March 11 to April 25 the expense was taken up by the Mississippi levee board on high-water account. In connection with the Stop Landing work, the protection levee presents peculiarly interesting features in that the high-water fight was made on a small levee built as a protection against the January rise. The high-water fight conducted in April devolved upon the levee board, and rather than trust to the completion of the Stop Landing loop, then sinking, they decided to make the fight on the protection levee. To do this, very rapid and decisive work was required to raise and enlarge the protection levee with the water already against it. The work proved very successful, restraining a flood within a foot of 1897 water, with the necessary work being done even in the face of the flood. Great credit is due to Mr. Luther Y. Kerr, inspector in charge, for the manner in which the fight was conducted.

Huntington Short Line.—This is a new levee under construction from Mound Landing to a point about 1¼ miles below Offutts Landing. The new levee here is 4.4 miles in length, and will shorten the levee line 7 miles over its present length. The new levee is divided into seven sections, two of which are completed, other sections being fairly well advanced. The work on this line has suffered two interruptions in having forces drawn off in January and March for assistance in the relief of the Stop Landing situation.

Surveys.—One of the surveys made during the year for new lines other than the closing of crevasses and the Huntington Short Line was for a line from Buck Ridge to Jenkins Landing, throwing out more of Catfish Point. This line is heavy, through low ground, and would be expensive to build. A survey has been partially completed for a line down the east bank of Lake Bolivar, throwing out all of Catfish Point. Another survey and location of a new levee has been made, absorbing a part of two enlargement contracts. It begins about 6¼ miles above Greenville, at Station 4233, and connects at Station 4315. This line is 6,600 feet in length. The adoption of this new line is in lieu of the enlargement of an old levee that is uncomfortably near to a bank, so that even a slight caving would breach it.

Caving bends.—There has been no very pronounced caving in this subdistrict. There has been some loss of bank in Choctaw Bend and at Greenville, threatening the levee at the latter place.

Levee repairs.—This work was done by force account on bids opened July 13, 1897, and applied to the line from the head of Vermilion Lake, Station 2160, to Station 2320, and from Stations 2450 to 2650. The work consisted in repairing gullied and wave-washed slopes and resodding the levee. The work proved very satisfactory.

Weed cutting.—This was done by contract from Stations 3930 to 4560 on bids of H. R. Valliant of 27.5 cents per station of 100 feet, cutting and clearing weeds from crown and land side of slope. Weed cutting was done by force account from Stations 840 to 1058 and 2320 to 2620.

High water, 1898.—The protection of levees during the high water of April, 1898, was undertaken and carried on by the Mississippi levee board. No breaks having occurred in the levee line for this season, the high water of 1898 presents a very uniform and satisfactory slope for laying future levee grades. High-water marks have been taken for the entire length of the line at intervals of about three to the mile. The height of water is indicated by spikes driven in trees, with "98" stamped just under the head. In addition to these marks, the levee board had taken an elevation of the height of water reached at intervals of 1,000 feet throughout the district.

The height the water reached near the upper end of the district ranged from 1 to 1½ feet below high water of 1897, whereas at Greenville, 1898, water approached within half a foot of 1897.

RECAPITULATION OF YARDAGE.

The yardage added to the levee line in the Lower Yazoo district north of Greenville for the year ending May 1, 1898, is as follows:

By the United States	3,476,439
By the levee board	143,675
Total	3,620,114

The above yardage may be regarded as permanent improvement, and does not include spur dikes and protection levees.

For location of work, extent of contracts, cost, and averages I would respectfully call attention to tabulated statement accompanying this report.

Very respectfully,

J. D. VAN METER, *Assistant Engineer.*

Capt. H. C. NEWCOMER,
Corps of Engineers, U. S. A.

REPORT OF MR. H. ST. L. COPPÉE, ASSISTANT ENGINEER.

GREENVILLE, MISS., *May 5, 1898.*

CAPTAIN: I have the honor to submit the following report of operations in the Lower Yazoo Levee district below Greenville during the fiscal year ending May 5, 1898:

Acting under instructions contained in your circular letter dated May 29, I assumed local charge of the levees in the Lower Yazoo Levee district below Greenville about June 1, transferring the Upper Tensas district above Greenville to United States Assistant Engineer E. C. Tollinger. In making the transfer, all notes, maps, letters, reports, etc., pertaining to the latter district were delivered to Mr. Tollinger and the working force of assistants transferred to his jurisdiction.

At that time the water was at about the 30-foot stage on the Greenville gauge and the great flood of 1897 was subsiding.

Two crevasses had occurred in the subdistrict; one at Deerfield, Stations 790 to 811, and the other at Shipland, Stations 3551 to 3601.

The receding water showed caving banks in near proximity to the levee in the following reaches:

	Stations.
Below Leota	2000 to 2100
Homochitta	3080 to 3100
Shipland	3480 to 3551
Hays	4000 to 4200
Duvalls to Chotard	4700 to 5000

The entire line before the flood was in bad condition generally, about 50 per cent being composed of old levees built prior to 1867, enlarged from time to time by levee board and Government, and nearly 80 per cent before 1886, when the stumps and other perishable materials were not removed from the foundations in construction and the specifications were very imperfect.

A survey of the line had been made in the winter of 1896, giving existing grades and cross sections every 500 feet; also the physical features, berm, depth, width of old pits, etc.

After the subsidence of the flood a partial resurvey was made showing the elevation of the crown of the levee and the proximity of the nearest caving bank. It was found that the levee had sunk in a number of places during the high water, notably from Stations 860 to 920, 1400 to 1580, 1880 to 1920, 2750 to 2790, and 2960 to 3060.

The grade of the levee from Stations 0 to 240 averaged but a few tenths of a foot above the high water of 1897; thence to Station 330 (the Warfield loop) it was about a foot higher. From Stations 330 to 3460 (Shipland) the grade of the existing line varied, being in a few places below and in a few places above the high water of 1897, but the average, not taking into account the half topping put up during the flood, showed a very little, if any, above the 1897 line. From Shipland to the end of the subdistrict (Station 5200), with the exception of one or two short reaches, the crown is about a foot above the last flood. Much of the line has a weak section, the landside slope being quite steep and liable to slough during high water.

The resurvey reestablished the elevation of the iron benches and determined that of the high-water slope as shown on high-water gauges read during the flood.

Construction.—The allotment for levee work in the Third district having been made and estimates and profiles submitted, bids were advertised for July 21, 1897, for new work and enlargement in the subdistrict as follows:

	Cubic yards.
Enlargement, Stations 0-60, 479-L	77,000
New loop (closing crevasse), Stations 790-811, 492-L	97,000
New loop (closing crevasse), Stations 3551-3601, 545-L	97,000
New loop, section 1, Stations 4868-4913, 569-L	119,000
New loop, section 2, Stations 4913-4958, 569-L	125,000
New loop, section 3, Stations 4958-5012, 569-L	121,000

August 11, 1897, the bids were opened and awarded as shown in the accompanying statement.

Bids were again advertised for and contracts made August 31, 1897, at prices also shown in accompanying statement, for work, as follows:

	Cubic yards.
Enlargement, Stations 60 to 100, 480-L	43,000
Enlargement, Stations 100 to 150, 480-L	55,000
Enlargement, Stations 150 to 200, 481-L	55,000
Banquette, Stations 6 to 100, 479-L	32,000
Banquette, Stations 100 to 200, 480-L	33,000

During the year the crevasse loops and the loop from Ingomar to Chotard have been completed, and the other contracts have progressed as shown in statement.

A fair start was made on the construction of the short-time contracts, when yellow fever was announced at Edwards, a small town about 15 miles east of Vicksburg. The disease was of a mild type, but very contagious. At once a strict quarantine was established in Issaquena and Washington counties by the State and local authorities; also every town, great and small, procured a shotgun guard. In many instances, when the county health officers desired and attempted to maintain a rational quarantine system, allowing safe limits to traffic and intercourse, these localities prevented such systematic procedure by an arbitrary usurpation of authority, putting a stop to all business, including levee construction. Under these conditions the work was necessarily retarded, it being impossible to get the required labor, not only because of the difficulty of passing the quarantine, but also for the reason that laborers would not come to this part of the country during the prevalence of the yellow fever.

From about September 15 to November 2, just at the time when the weather was most favorable for levee construction, the strictest quarantine was maintained and traffic, during a part of the time, by land and water suspended. The contractors experienced much trouble in getting supplies and feed for their mules. Labor could not be obtained in large quantities until nearly the 1st of December.

In addition to the trouble caused by the quarantine, the right of way was not obtained in full on the Ingomar to Chotard loop until November 5, thus increasing the delay and hardship to the contractor at that point.

Levee board construction.—December 9 it became apparent that some steps would have to be taken to provide for the caving below Homochitta Landing. The bank was receding rapidly, threatening the destruction of the levee in a short time and just as the river was expected to overtop its banks. A loop was located by the Government and constructed by the levee board as shown in accompanying statement. The caving has since stopped and the front levee remains intact to the present date.

Weed cutting.—July 31 a contract was made with Vaughan & Co., of Greenville, Miss., to cut the weeds from the levee in the subdistrict for 35 cents per station and in the following manner:

From Greenville, Station 0, to Avon, Station 1120, weeds and small trees from crown and land-side slope, including banquette.

From Avon, Station 1120, to Leota, Station 1900, crown and land-side slope, including banquette.

From Leota, Station 1900, to Albermarl, Station 4866, crown and both slopes.

From Chotard, Station 5013, to Brunswick, Station 5200, the same.

Owing to the strict quarantine regulations the contract had to be abandoned after the following work was completed:

	Stations.
Stations 0 to 790	790
Stations 810 to 1616	806
Stations 2970 to 3551	581
Stations 3601 to 4866	1,265
Stations 5013 to 5190	77
Total	3,519

Topping.—In the latter part of January heavy rains in the Ohio and Cumberland valleys produced at Cincinnati a stage of 52 feet and at Nashville one of 38 feet. February 1 the combined influence of the two corresponding streams brought the water at Cairo to 44 feet, and, augmented by exceedingly heavy and continuous precipitation in the Lower Mississippi Valley, twelve days later to 37.9 feet at Greenville.

At that time the short-time contracts (crevasse loops) were still incomplete, and a continued rise would have caused very active operations to prevent a disaster. Fortunately the water declined at once and the breaks were closed without difficulty.

In anticipation of a prolonged rise, topping was undertaken and completed to the amount of 25,193 cubic yards.

It was proposed to extend the topping work to other reaches where the levee is low, but restricted funds prevented.

Wooden stakes.—In addition to the iron benches that are located 1,000 feet apart, wooden stakes 3½ by 3½ inches in section, painted red, with figures cut into the wood, have been placed every 5,000 feet, to facilitate the location of the different reaches of levee during inspection.

By the construction of tool or section houses every 5 miles on the levee great advantage would be gained during high water, as well as at other times in the year, when weed cutting and general repairs are in operation. Drawings and estimates for such houses were submitted in February.

Flood of 1898.—After the decline of the river in March to 15 feet at Greenville the general opinion was that no further high water would prevail this season. This opinion was incorrect, as demonstrated by the flood that has just passed.

Heavy rainfall in the Ohio Valley in the latter part of March produced a stage of 61 feet at Cincinnati. This was increased but slightly by the Cumberland and Tennessee, but extensive floods in the Illinois and Wabash rivers combined with the Ohio water to cause a stage of 49.8 at Cairo. This gave 37.3 at Memphis, 49 feet at Helena, and, augmented by a high water from the Arkansas and White, 51.2 feet at Arkansas City and 46.2 at Greenville.

The wave was sharp and rapidly propagated, declining quickly at all points. Owing to a narrow channel, contracted by a railroad embankment, the Memphis stage reached nearly that of 1897. The effects of the openings below Helena, combined with the smaller return from the St. Francis, caused a depression in the flood plane at that point. The White and Arkansas waters carried the elevation to near last year's water from Arkansas City to Greenville. Thence to Brunswick it will be noticed on the high-water profile that the flood conformed very nearly in height to that of 1897, being a little above or below the latter in a number of reaches in this subdistrict.

In accordance with an act of the legislature of Mississippi, the board of levee commissioners were allowed to issue bonds to the amount of $75,000 for the maintenance of the levees during high water.

Other than supplying barges, quarter boats, outfits, tools, etc., the Government took no part in the high-water operations, except by turning over to the chief engineer of the levee board all available assistants who were experienced high water men. Mr. A. M. Todd, inspector from this subdistrict, was given charge of a high-water division by the levee board.

The very high stage of water was successfully combated by Major Starling and his assistants, notwithstanding the fact that much of the line was in a very dangerous condition. In long reaches the seepage water passed through the levee in great quantity, and numerous bad sloughs occurred, but owing to the almost continuously clear weather and freedom from high winds these were controlled.

A statement of the condition of the levee during high water and the materials used in the emergency is submitted herewith.

The amount of money expended below Greenville, as derived from the secretary of the levee board, was $41,512.

In addition to the work necessitating the use of lumber and sacks a number of long reaches were topped with teams during the flood, as shown on accompanying statement.

The backwater from Steeles Bayou and the Yazoo reached the levee at Station 4700, and on the Yazoo and Mississippi Valley Railroad it was up as far as Valley Park station. (See map of third district.) Heavy rains in the Yazoo and its tributaries caused more backwater than would have otherwise been experienced and prevented the normal decline at Vicksburg.

New work.—It will be impossible to determine the amount of new work necessitated by caving in time to accompany this report, as the water will not be within the banks before the 5th instant.

A new loop will probably have to be constructed from Station 4686 north toward Duvalls and from Station 2000 to 2110. At Hays and Shipland the levee will probably remain intact for another high-water season.

During the flood three parties have been employed determining the line of saturation in levees that had new loops behind them and in the new Deerfield Levee, a report of which will be submitted as soon as the notes can be plotted.

The accompanying statement shows the following percentages of expenditure during the year.

	Amount.	Per cent.
Construction	$90,951.68	90.50
Repairs	1,318.41	1.25
Engineering	8,325.86	8.25
Total	100,595.95	100

The yards of material in the levees in the subdistrict are approximately as follows:

In levee May 1, 1897	8,355,637
New work 1897 and 1898	769,467
Topping by Government in January	25,193
Topping by levee board	10,000
Total approximate	9,160,297

Approximate yardage required to raise the levees in the subdistrict to a grade 3 feet above high water of 1897, including banquette and loops necessitated by caving banks, 7,000,000 cubic yards.

* * * * * * *

Yours, respectfully,

H. St. L. Coppée,
Assistant Engineer.

Capt. H. C. Newcomer,
Corps of Engineers, U. S. A.

REPORT OF MR. E. C. TOLLINGER, ASSISTANT ENGINEER.

Greenville, Miss., *May 8, 1898.*

Sir: I have the honor to submit the following report on the surveys, construction, and repairs of levees in the Upper Tensas Levee district in Arkansas for the period from May 1, 1897, to May 1, 1898.

Acting under instructions contained in your letter of May 29, 1897, I took charge of all the levees in this district on June 17, 1897, transferring to Assistant Engineer H. St. L. Coppée all maps, profiles, etc., of the Lower Yazoo Levee district below Greenville.

The Upper Tensas Levee district in Arkansas comprises the levees from Red Fork, on the right bank of the Arkansas River to the lower end of Lake Jefferson, and from high land on Amos Bayou at Costello's gin to the Louisiana line, a distance in all of 97 miles. From Costello's gin to Lake Jefferson there is no levee.

No work has been done on the Arkansas River Levee from Red Fork to Lake Jefferson since 1896. It is the intention of the Mississippi River Commission to extend this levee to the mouth of Cypress Creek when funds are available, thus cutting off the flow of flood water which now enters between the two systems.

Shore line.—There has been no pronounced change in the shore line except at Vaucluse. At this point the bank has caved 400 feet and is within 825 feet of Whiskey Chute Levee. The caving has been uniform in Rowdy, Spanish Moss, and Mathews bends, being from 50 to 100 feet in each.

Construction.—The proposed grade of the levee system was, in the last Annual Report when submitted, 3 feet above high water of 1897. The following levees were then under construction:

Stations.	Distance below Cairo.
0–120	(Amos Bayou line.)
798–886	437 R.
1080–1200	441 R.
1510–1630	451 R.
1630–1730	452 R.
1741–1781	453 R.
2316–2488	485 R.
2488–2562	487 R.
3483–3599	506 R.
3760–3945	510 R.
3945–4110	515 R.
4121–4208	517 R.
Bids opened Aug. 11, 1897.	
120–250	(Amos Bayou line.)
180–230	Do.
1810–1941	466 R.
3065–3100	496 R.

Fair progress was being made on these contracts, with the exception of Stations 3065–3100 (which were not commenced), when yellow fever broke out at Edwards, Miss., a small town east of Vicksburg on the Alabama and Vicksburg Railroad. As soon as the Government officials made known the presence of yellow fever the local authorities and the people established a shotgun quarantine, which prevented contractors from obtaining supplies and labor to carry on their contracts successfully, and prevented the undertaking of new work by them for a period of about sixty days at the very time when the work could have been done to most advantage. The strict enforcement of the quarantine regulations prevented the completion of the contracts on time and extended the time into the wet season, which cost the contractors more than the contract price besides entailing additional expense on the part of the local boards.

These contracts are all completed except Stations 180–230, 1810–1941, and 1080–1200. The incomplete stations on these contracts were topped in advance of the high water of 1898 at the expense of the contractors.

Bids opened August 31, 1897:

Stations 420–484	427 R
Stations 630-660	430 R
Stations 780–800	432 R
Stations 1490–1510	449 R
Stations 1740–1780	452 R
Stations 3160–3185	498 R

No work has been done on these contracts except topping in advance of the high water.

Statement of material in levees May 1, 1897, to May 1, 1898.

	Cubic yards.	Cubic yards.
Red Fork Levee, May 1, 1898		588, 833
Costello's Gin-Columbia	5, 994, 000	
Less Amos Bayou Break	6, 000	
		5, 988, 000
Levees, Columbia to Louisiana line		4, 514, 898
Total May 1, 1897		10, 561, 731
Material added—		
By United States, May, 1897-98, contracts	704, 949	
By United States, May, 1897-98, topping	35, 235	
By Tensas Basin board	10, 000	
By Tensas Basin board, topping	63, 575	
By Tensas Basin board, topping	9, 150	
By Chicot local board, new line	65, 669	
		888, 578
Total yardage May 1, 1898		11, 450, 309

The approximate yardage required to raise the levees of this subdistrict to a grade 3 feet above the high water of 1897, including banquettes and loops necessitated by defective levees, will be:

	Cubic yards.
Enlargement	1, 693, 900
Banquette	1, 088, 766
New loop (stations 600–894)	742, 987
Total	3, 525, 653

NEW LINES.

Leland Short Line (*485 R*).—A survey was made, levels run, and quantities computed for five different locations of this line, as follows: Stations 2047 to 2130+70, 2015+50 to 2103+60, 2096 to 239+24, and 55+30 to 156+20, and the line finally adopted (which was cross sectioned for construction) between stations 2146+75 and 2186+14. This work was undertaken by the Chicot County Levee board.

Vaucluse (*Whisky Chute*) *Levee.*—The occasion for this survey was the rapid rate of caving at and below Vaucluse, which, if continued, will endanger the existing levee. A preliminary line was run from Station 2502 to 2562 (old enumeration), levels run, estimate of quantities, tracing and blue prints made and sent your office. A comparison was also made between this line and one around Lake Chicot, the survey for which was made by Mr. Henry Goodrich in 1888, and results forwarded..

Stations 600–900 (*West of Cypress Lake, 430 R*).—A location of a new line as above has been made, quantities computed, and profile prepared.

Enlargement.—Levels were run, cross sections made and profiles prepared, and notes computed for the work let August 11 and 31, 1897.

High-water protection.—The high water of 1898 differed from that of former years in its rapid rise and fall, remaining only about four days at its maximum height, which was as follows:

	Feet.
Cairo	49.8
Helena	49.1
Arkansas City	51.2
Greenville	46.2

The discrepancy between the Memphis and Helena gauges, compared with 1897, was due to construction of a railroad embankment opposite Memphis and openings in the Arkansas levee system south of Helena.

Uncertainty, caused by a probability of heavy rains in the upper valleys augmenting the flood in sight, made it necessary to prepare for even a higher water than in 1897. To have avoided these expenditures would have been entirely out of sound practice, as a delay of a few hours at the most critical period might have cost the country millions of dollars. The flood of 1897 had thoroughly saturated the levees and solidified them by water tamp, which added much to their effectiveness in this year's flood.

Seepage.—Seepage was much more pronounced in some localities than in 1897. Why this should be the case is a question, as the water remained only a few days as compared with that year.

Organization.—Organization for high-water protection was begun by dividing the district into ten sections. Barges were loaded with lumber and located at convenient points, and additional sacks and lumber were delivered at points between, with tools. Quarter boats were fitted up at Greenville in readiness for immediate use. Only one of these was used, being used by force at Lucca.

Flooded area.—The area covered by the flood of 1898 corresponds in this district above Gaines Landing very closely to that of 1897, and below this point is much less. The whole area covered this season would have corresponded very closely with that of last had the water remained as long at the maximum height, which, at the time the observations were taken, was about the same as when those of 1897 were taken. The latter were taken after the crevasses, when the water had fallen a foot at Costello's gin.

Cypress Creek outlet.—To protect this back country from flood water, a line of levee is required from the Arkansas River system to the Mississippi River system, closing on the main line about Station 80. This would require the closing of Cypress Creek and opening up Boggy Bayou and other drainage channels at a heavy expense, which can only be determined by making surveys. Continuing the Arkansas River system to the mouth of Cypress Creek would give absolute protection, except in the case of prolonged floods above 51 feet on the Arkansas City gauge. The local boards seem united on the importance of extending this line to Cypress Creek, and are working together for that end. The total of available funds from all these boards is small when compared with the amount required. In view of this they expect assistance from the United States. Surveys and estimates have been made for both these lines as described above, the results of which are on file in your office.

The discharge between the levees was about 100,000 cubic feet per second. The country affected by this discharge is shown on the accompanying map of overflow area. The duration of this overflow was comparatively short, causing at this season of the year but little damage to the planting interests.

Remarks on the flood of 1898.—The high water of 1898 was not so great as that of 1897, the difference being as follows:

	Feet.
Red Fork	1.85
End Lake Jefferson	1.25
Costello's gin	1
Station 353	1.25
Station 920 (Arkansas City gauge)	.7
Greenville	.5
Station 2848	.25
Station 3040	.20
Station 3760 (Grand Lake)	.15
Station 4049 (Sterling)	.10
Station 4206, same as 1897.	

These differences are mainly due to crevasses, in 1897, north of Arkansas City. The maximum height was reached at Greenville April 19, the river remaining stationary until April 23, when a decline set in which has continued. In 1898 the water remained at its greatest height a longer time than in 1897. When crevasses occurred in 1897 the river was rising six-tenths of a foot every twenty-four hours. Immediately afterwards the fall set in, but only continued until the river had fallen about 1.5 feet, the river remaining against the levees for about twenty-five days afterwards the time period in all for 1897 that the river was against the levees being in this district about sixty days as against thirty-five days in 1898. The expenditure for high-water protection in my subdistrict was for this year only about 10 per cent of that of 1897.

For the most part the levee in my district gave no signs of weakness, the exceptions being short sections of old levee. These sections were well drained and gave little trouble or expense. The sand boils were generally in the levees where the formation seemed to be mostly of a silty nature. These seem to threaten the safety of the levee from Stations 630 to 660 and Stations 710 to 745. The floods of 1897 and 1898 brought out the fact that wave wash can be reduced to a minimum by keeping the levees well sodded with Bermuda grass.

High-water marks.—Boat spikes $\frac{4}{8}$ inch by 7 inches stamped with "98" mark the high water of 1898. These have been connected with the "stone line benches" and their elevations and locations recorded with as great accuracy as the bench marks and can therefore be regarded as bench marks of this line.

Recommendations for new work.—The observations taken during the flood of 1897 and 1898 from Stations 600 to 900 seem to warrant the construction of a new line west of Cypress Lake as soon as practicable. The old levee, as now located through the Middle and Chicot plantations, is on a very faulty foundation, which will require an expensive muck ditch and heavy enlargement to make it safe. There is, in addition to this, every prospect of the present location being endangered by the caving of the bank. To move the line back would be much more expensive than the line suggested west of Cypress Lake. The stations from 800 to 900 have a very rotten foundation and can only be made safe by rebuilding. This matter is of so much importance that it should receive attention as soon as funds are available. Owing to the limited amount of funds available for enlargement, and the fact that the levee from Stations 2650 to 3338 is but little above 1898 water, it is recommended that this section be topped to a grade 3 feet above 1897 water, requiring about 45,000 cubic yards, at 25 cents, or about $11,250.

Specifications.—The levees built in accordance with the specifications of 1896 gave no trouble during the high water of 1898. As the levees will in future be required to stand a greater pressure than in either 1897 or 1898 (at least 2 or 3 feet more water, in my opinion), the layers should be reduced, in future construction, from 2 feet to 1 foot, and the levee completed by the earth being dumped one way toward the completed portion. The contractors seriously object to these layers, but their objections are not well sustained. The change should be made, even if the price per yard has to be slightly increased. On sections where forced to use silt in construction the land-side slope should be one on ten.

Stone bench marks.—To better mark the line of levee, it is recommended that stone benches placed 3,000 feet apart be substituted for the iron benches now in use. The chief reason for this change is due to the people living along the line removing the caps, and sometimes sections of pipe, to be used in sinking drive wells. In addition to this the numbers on these pipes are not plain after they have been exposed a short time, which would not be the case with stone. These stone benches will not cost a great deal more than the iron ones.

A blue print showing overflowed area accompanies this report in a separate package. List of expenditures of the United States and the Tensas Basin Levee board, and Desha and Chicot County Levee boards, together with table showing cost of construction and labor statement, and statement of distribution of labor and material in high-water protection, inclosed.

I wish to thank the people generally for their assistance during the high water, and my assistants generally for their faithful and efficient service.

Very respectfully,

E. C. TOLLINGER, *Assistant Engineer.*

Capt. H. C. NEWCOMER,
Corps of Engineers, U. S. A.

REPORT OF MR. W. S. BROWN, ASSISTANT ENGINEER.

LAKE PROVIDENCE, LA., *May 7, 1898.*

SIR: I have the honor to submit the following report of operations in the Upper Tensas district in Louisiana from May 1, 1897, to May 1, 1898.

Construction.—All contracts for 1896–97 in existence at the date of the last annual report have been completed and final estimates issued therefor, except the one from Stations 0 to 256, which is complete as to embankment and sodding, but the contractor has thus far failed to do the slashing, as required by the specifications. The final estimate, covering the reserved percentage ($2,037.61), has been withheld. None of the contracts for 1897–98 have been completed. All of the short-time contracts (to be completed February 1, 1898) have been begun except the one from Stations 4409 to 4432 (603–R). Though the contractor had sufficient team force on the ground in January last to have completed the work in six weeks, and though repeatedly urged to begin work, he allowed his force to remain idle for more than a month, and subsequently removed it.

Crevasse work.—The other short-time contracts, four covering the break in Biggs Levee, Stations 4432 to 4507 (604–R), and the other the break in Reid Levee, Stations 4540 to 4551 (605–R), were begun after the quarantine restrictions of last year were removed. Surveys were made for these two loops in July last, for a grade 3 feet above the high water of 1897, which stood 52.5 on the Vicksburg gauge. Shortly after work was commenced on the Biggs loop, and when only a few stations had been completed to adopted grade, it was thought best, in view of the great difficulties in the way of a more rapid progress of the work and the short time to the probable recurrence of the spring floods, to limit, temporarily, the construction to a grade 4 feet lower than that adopted, i. e., to a grade 3 feet above a 48.5 stage on the Vicksburg gauge. On this basis the work was prosecuted as vigorously as possible, with the result that the levee was completed to the lower grade in time to meet the flood of April, 1898, and withstood a 49.4 stage of water on the Vicksburg gauge. In the meanwhile, however, to insure protection against a rapidly rising river in January, to avoid interruption of work along the main line and to prevent destruction of embankment already in place, a protection levee 2,500 feet long, containing 22,194 cubic yards, was rapidly constructed along the line of the old levee, utilizing portions thereof that had not been washed away by the break of 1897. This effectually accomplished the objects in view.

At Reid Levee, however, the same success did not attend our efforts. The protection levee at that point, constructed with the same object in view, broke on February 3, permitting a limited volume of water to flow over the lower incompleted stations and causing portions of the earth recently placed to be washed away. A detailed statement of the circumstances preceding and attending this break has been forwarded to you. The deep and extensive swamp through which this levee runs, with its natural outlets, contained the inflow of water, and little damage was done except by interruption of work.

After the subsidence of the January rise work was resumed with a largely increased force, and it is now nearing completion, having attained sufficient grade and section to withstand the April flood.

On the four sections of Biggs Levee, including banquette to within 8 feet of grade with 20-foot crown, 1 on 10 crown slope and 1 on 4 back slope, contemplated in the original plan of construction, there remains to be placed to complete same to the full grade first adopted:

	Cubic yards.
On stations 4432 to 4452	22,717
On stations 4452 to 4472	48,729
On stations 4472 to 4492	51,090
On stations 4492 to 4507	16,939
Total	139,475

On the Reid loop there remains to be placed 21,580 cubic yards, upon which work is progressing, and it should be completed in six weeks.

Caving banks.—There has been no marked or extensive caving at any point except at Salem Landing, in the bend below Goodrich (564–R.). Caving here has progressed steadily for the past several years, and from recent observations there has been a loss of about 1,500 feet of bank since the construction of the Salem Levee by the Government in 1893-94.

Considerable caving has recently developed at Point Lookout, in the bend below Lake Providence (550–R), the extent and progress of which can not yet be determined. Slight caving at three points where the levees are near the river banks, has necessitated the construction of new levees or loops by the local authorities, viz: Station 1119, (534–R); Station 3295 (581–R), and Station 3718 (590–R). A statement of the extent of this work, together with other work of enlargement by the local authorities during the year, is forwarded herewith.

Flood of 1898.—The high water of 1898 reached a stage of 44.35 feet on the Lake Providence gauge, as compared to 44.40 for 1897, the highest stage recorded. From Ashton to the old cross levee at Point Lookout, Stations 0 to 1985, the same relative difference existed; from Point Lookout to the lower end of the district there was a gradual decrease in height, as compared to that of 1897, reaching a maximum difference of 3.1 feet at Vicksburg.

Special care was taken to secure a line of high-water marks, which was done by driving large spikes in trees adjacent to the levees, about a half mile apart, thus affording a perfect grade line.

The banquettes constructed along the entire line of levee in this subdistrict during the years 1894, 1895, and 1896, have, I think, proved their value and efficacy. They were constructed back of all levees more than 10 feet in height, and were brought to a grade 8 feet below the grade of levees, having 20-foot crown, 1 on 10 crown slope, and 1 on 4 back slope.

During the high waters of 1897 and 1898 special attention was given to the drainage of the levees, and where it was possible to find an outlet without too great expense no water was allowed to remain on or near the levee. This I consider of the utmost importance.

Very little work was done in high-water protection this year, and scarcely any would have been necessary, except drainage, had not this immediate section around Lake Providence been visited by a severe windstorm, blowing from the southeast, on the morning of April 22. This caused considerable damage at exposed points along the line from Stations 1080 to 1600, which damage was repaired, the badly washed out places being protected by revetment of plank and sacks of earth as speedily as possible, the water being then at its highest.

The contracts completed during the year suffered much from wave wash, extending far into the crown. I respectfully recommend that this wave wash be restored and thickly sodded as soon as practicable.

I attach hereto and make part hereof a labor statement, showing fully the details of construction.

Very respectfully,

W. S. Brown, *Assistant Engineer.*

Capt. H. C. Newcomer,
Corps of Engineers, U. S. A.

Levee work in Lower Yazoo district above Greenville, May 1, 1897, to May 1, 1898.

[E. = Enlargement; N. = New.]

Stations.	Miles below Cairo.	Contractors.	Cubic yards in contract.	Cubic yards placed during year.	Total laborers.	Total teams.	Total scrapers.	Yards per team.	Yards per scraper.	Price per cubic yard (cents).	Average height, (feet).	Average haul, (feet).	Kind of work.
0– 100	367 L	Ernest Hyner......	140, 072	124, 887	6, 157	4, 236	2, 839	29. 5	44. 0	11. 9	15	210	E.
100– 200	369 L	Arnold & DeGaris..	151, 006	137, 066	5, 782	4, 135	2, 735	33. 1	51. 2	11. 4	15. 6	180	E.
200– 300	370 L	C. A. Winter	147, 649	113, 916	4, 944	3, 734	2, 499	30. 5	45. 6	12. 87	14. 7	250	E.
300– 400	372 L	Ernest Hyner	115, 776	81, 655	3, 108	2, 227	1, 418	36. 7	57. 6	13	14. 1	300	E.
400– 500	374 L	.....do...............	121, 750	106, 206	4, 543	3, 220	2, 254	33	47. 1	11. 5	15. 3	250	E.
500– 595	376 L	E. B. Mantle	119, 266	90, 868	4, 555	3, 211	2, 302	28. 3	39. 5	12	13. 9	240	E.
595– 625	377 L	H. F. Watkins	88, 646	88, 646	6, 302	3, 457	*2, 533	25. 6	35	10. 45	13. 8	160	N.
625– 641	377 L	.....do...............	44, 827	44, 827	1, 660	1, 181	833	37. 9	53. 8	10. 45	14. 1	175	N.
618– 700	377 L	L. C. Dulaney	56, 436	56, 436	2, 609	1, 803	1, 224	31. 3	46. 1	9. 23	15. 2	160	E.
700– 800	378 L	T. S. Aderholdt	60, 637	48, 633	2, 066	1, 438	981	33. 8	49. 6	10. 74	15. 8	140	E.
800– 900	378 L	.....do...............	102, 324	102, 324	4, 220	3, 044	2, 163	33. 6	47. 3	10. 24	18. 6	260	E.
900– 999	379 L	W. A. Shippey	97, 452	78, 797	3, 503	2, 602	1, 824	30. 3	43. 2	17. 98	14. 1	125	E.
999–1018	380 L	McIntyre & Howard	75, 883	75, 883	5, 283	3, 856	2, 689	19. 7	28. 2	12	16	165	N.
1018–1034	380 L	.....do...............	64. 793	64, 793	9, 177	3, 497	†2, 307	18. 5	28. 1	12	17. 4	225	N.
1034–1051*a*	380 L	.....do...............	66, 387	66, 387	2, 735	1, 898	1, 272	35	52. 2	12	16. 4	170	N.
1037*a*–1200	392 L	Stone & Stansell...	171, 086	83, 434	3, 126	2, 184	1, 476	38. 2	56. 5	15. 48	16. 8	185	E.
1200–1300	395 L	T. S. Aderholdt	80, 841	59, 657	2, 527	1, 948	1, 504	30. 6	39. 7	10. 74	15. 2	180	E.
1300–1400	396 L	P. F. Lamb..........	63, 793	63, 793	2, 185	1, 721	1, 147	37. 1	55. 6	12. 5	15. 5	180	E.
1400–1500	398 L	Robert Johnsen....	85. 655	66, 222	3, 328	2, 445	1, 605	27. 1	41. 3	14	16. 7	210	E.
1500–1600	399 L	Ernest Hyner......	95, 869	84, 286	3, 426	2, 405	1, 634	35	51. 6	12	17. 4	210	E.
1600–1700	401 L	C. A. Winter	72, 238	58, 432	2, 898	2, 043	1, 434	28. 6	40. 7	10. 63	16. 2	200	E.
1700–1800	401 L	J. B. Lewis..........	82, 202	59, 544	3, 120	2, 010	1, 368	29. 6	43. 5	10. 99	16. 2	210	E.
1800–1900	403 L	W. A. Shippey	116, 875	82, 418	3, 500	2, 445	1, 727	33. 7	47. 7	11. 48	18. 2	225	E.
1900–2000	405 L	Ernest Hyner......	114, 097	104, 056	4, 597	3, 151	2, 162	33	48. 1	12	18. 5	190	E.
2000–2066	407 L	W. M. Bates & Co..	78, 735	78, 735	4, 315	2, 919	2, 002	26. 9	39. 3	13	14	210	E.
2620–2700	418 L	Green Clay	84, 112	84, 112	3, 985	2, 763	2, 000	30. 4	42. 1	13. 6	17. 4	200	E.
2700–2800	419 L	McCadden & Roach.	137, 000	42, 966	1, 969	1, 334	968	32. 2	44. 4	12. 23	16. 6	175	E.
2959–3000	431 L	Ernest Hyner......	30, 693	30, 693	1, 750	1, 175	870	26. 1	35. 3	12	15. 5	100	E.
3000–3100	431 L	.....do...............	107, 000	16, 971	605	421	315	40. 3	53. 9	12	16. 2	150	E.
3100–3186	433 L	.....do...............	92, 500	63, 766	3, 136	2, 216	1, 584	28. 8	40. 3	16	17. 6	160	E.
3186–3201	434 L	Robert Johnsen....	81, 303	81, 303	4, 350	3, 126	2, 188	26	37. 1	14. 74	18. 1	350	N.
3201–3215	434 L	.....do...............	112, 572	112, 572	6, 256	4, 630	3, 586	24. 3	31. 4	14. 74	22	700	N.
3215–3259	434 L	.....do...............	94, 576	94, 576	4, 826	3, 374	2, 345	28	40. 3	14. 74	15. 3	250	N.
3225*b*–3282	435 L	McLeod & McCarten	65, 937	65, 937	2, 970	2, 295	1, 661	28. 7	39. 7	13. 45	16. 6	150	E.
3282–3306	436 L	W. M. Bates & Co..	72, 915	72, 915	2, 810	2, 024	1, 432	36	50. 9	12. 5	14	140	N.
3306–3329	436 L	James H. Cary	78, 814	66, 362	2, 362	1, 769	1, 263	37. 5	52. 5	12. 5	15	150	N.
3329–3360	436 L	McIntyre & Howard	155, 000	20, 033	794	562	389	35. 6	51. 5	12. 98	18	170	N.
3360–3400	436 L	P. F. Lamb..........	154, 000	74, 185	3, 477	2, 539	1, 727	29. 2	43	13. 5	15. 5	155	N.
3400–3440	436 L	McLeod & McCarten	156, 000	128, 360	5, 521	4, 129	2, 701	31. 1	47. 5	12. 7	15. 8	160	N.
3440–3469	436 L	J. S. McTighe, B. C. & I. I. Co.........	156, 201	156, 201	6, 961	5, 023	3, 273	31. 3	47. 7	16. 93	18	185	N.
3469–3514	436 L	McLeod & McCarten	156, 179	121, 738	5, 834	4, 058	2, 923	30	41. 6	12. 7	15	155	N.
4200–4300	460 L	Ben Talley..........	183, 064	71, 217	2, 835	1, 974	1, 361	36. 1	52. 3	13. 95	15. 6	180	E. & N
4300–4400	475 L	McCadden & Roach.	114, 000	80, 657	3, 882	2, 820	1, 994	28. 6	40. 4	13. 4	14. 6	250	E. & N.
4400–4500	476 L	Timothy Sullivan ..	87, 000	8, 366	661	471	323	18	26	12. 95	14. 6	250	E.
4500–4570	477 L	.....do...............	61, 608	61, 608	3, 096	2, 258	1, 605	27. 3	38. 4	10. 75	13	175	E.

* Also 1,351 wheelbarrows.
† Also 3,889 wheelbarrows.

Respectfully submitted.

J. D. Van Meter, *Assistant Engineer.*

Levee work in Lower Yazoo district, below Greenville, May 1, 1897, to May 1, 1898.

[E. = Enlargement; B. = Banquette; N. = New.]

Stations.	Miles below Cairo.	Contractor.	Cubic yards in Contract.	Cubic yards placed during year.	Total laborers.	Total teams.	Total scrapers.	Yards per team.	Yards per scraper.	Price per cubic yard (cents).	Average height (feet).	Average haul (feet).	Kind of work.
0- 60	479 L	Timothy Sullivan....	57, 500	51, 167	2, 913	1, 874	1, 256	27. 83	40. 75	10. 75	14. 8	100	E.
6- 100	479 L	C. A. Winter..........	28, 000	23, 924	1, 404	997	655	24	36. 5	9. 95	5. 3	140	B.
60- 100	480 L	L. C. Dulaney.........	43, 000	1, 118	47	33	23	34	48. 5	10. 23	14. 9	100	E.
100- 150	480 L	T. Mike................	45, 000	2, 750	119	89	60	31	46	9. 74	14. 7	100	E.
150- 200	481 L	.....do................	45, 000	13, 505	434	324	224	41. 75	60	9. 45	15. 1	100	E.
100- 200	480 L	Jno. G. Sessions.......	26, 000	15, 963	698	468	299	34	53. 5	9. 98	5	140	B.
790- 811	492 L	Timothy Sullivan....	88, 790	88. 790	5, 208	3, 732	2, 778	24	32	13. 97	15. 8	350	N.
3087-3113	533 L	Chilton & Sessions...	*a*73, 788	73, 788	3, 594	2. 183	1, 537	33. 75	48	20. 50	12. 7	....	N.
3551-3601	545 L	L. C. Dulaney.........	105, 608	105, 608	4, 605	3, 009	2, 123	35	49. 75	9. 95	12	200	N.
4868-4913	569 L	Ben Talley............	125, 601	125. 601	5, 885	3, 550	2, 340	35. 5	53. 75	14. 3	13. 7	....	N.
4913-4958	569 L	.....do................	139, 108	139, 108	6, 426	3, 631	2, 283	38. 25	61	14. 3	13. 7	....	N.
4958-5012	569 L	.....do................	128, 145	128, 145	5, 830	3, 593	2, 234	35. 75	57. 25	12. 7	12. 8	....	N.

a Work done by levee board.

Respectfully submitted.

H. St. L. Coppée, *Assistant Engineer.*

Levee work in Upper Tensas district, in Arkansas, May 1, 1897, to May 1, 1898.

[E. = Enlargement; N. = New; B. = Banquette.]

Stations.	Miles below Cairo.	Contractor.	Cubic yards in contract.	Cubic yards placed during year.	Total laborers.	Total teams.	Total scrapers.	Yards per team.	Yards per scraper.	Price per cubic yard (cents).	Average height (feet).	Average haul (feet).	Kind of work.
0- 120	(*a*)	J. M. Whitehill.......	45, 829	44, 356	2, 764	1, 511	088	29. 4	44. 9	12. 5	7. 5	150	E.
120- 250	(*a*)	J. H. Cary.............	59, 345	59, 345	3, 560	2, 508	1, 165	23. 3	50. 1	15	7. 5	175	E. & N.
180- 230	438 R	J. M. Whitehill.......	22, 000	18, 096	1, 142	843	510	21. 5	35. 5	13	16	225	B.
1080-1200	441 R	.....do................	112, 569	78, 500	5, 033	3. 288	2. 146	23. 9	36. 6	13. 99	18	200	E.
1510-1630	451 R	J. B. Lewis...........	98, 092	74, 980	3, 925	2, 373	1, 626	32. 4	46. 1	13. 73	16	200	E.
1630-1730	452 R	Arnold & DeGaris...	66, 711	52, 273	5, 236	1, 987	1, 324	26. 3	39. 5	19. 7	17	225	E.
1810-1941	466 R	J. V. Daugherty.......	160, 000	91, 478	6, 300	4, 038	2, 825	22. 6	32. 4	16	17	300	E.
2316-2488	484 R	Arnold & DeGaris...	102, 547	52, 174	3. 726	2, 217	1, 459	24	25. 8	17. 9	13	250	E.
2488-2562	487 R	C. A. Winter..........	55, 466	37, 480	2, 711	1, 863	1, 485	20	25. 2	22. 87	14. 6	450	E.
3490-3499	506 R	J. H. Cary.............	15, 227	14, 027	1, 275	749	565	18. 7	24. 8	25	22	600	E.
3758-3945	510 R	John G. Sessions.....	87, 798	60, 876	3, 146	2, 040	1, 517	29. 8	40	13. 33	13	200	E.
3945-4110	515 R	W. M. Bates & Co....	93, 871	69, 086	4, 736	3, 174	2, 211	21. 8	31. 3	15	16	400	E.
4110-4209	517 R	L. C. Dresbach.......	58, 441	52, 278	3, 196	1, 699	1, 135	30. 8	46. 1	14. 87	13	200	E.

a Amos Bayou line.

Respectfully submitted

E. C. Tollinger, *Assistant Engineer.*

Levee work in Upper Tensas district, in Louisiana, May 1, 1897, to May 1, 1898.

[E. = Enlargement; N. = New.]

Stations.	Miles below Cairo.	Contractor.	Cubic yards in contract.	Cubic yards placed during year.	Total laborers.	Total teams.	Total scrapers.	Yards per team.	Yards per scraper.	Price per yard (cents).	Average height (feet).	Average haul (feet).	Kind of work.
0- 256	520 R	Arnold & DeGaris	164, 323	135, 970	5, 231	4, 027	3, 021	34	45	12. 4	17	100	E.
756- 851	528 R	F. M. McLaughlin	62, 277	62, 277	3, 548	2, 328	1, 729	27	36	15	17. 4	150	E.
851- 930	529 R	Robt. Nicholson	53, 618	45, 814	1, 724	1, 225	889	37	51	10. 74	14. 6	90	E.
1450-1630	542 R	.....do	92, 250	60, 386	1, 953	1, 423	1, 003	42	60	10. 44	15	80	E.
2286-2368	560 R	.....do	64, 046	32, 894	1, 211	807	586	41	56	10. 74	18	100	E.
3328-3428	578 R	J. C. Hodge	119, 506	......	......	......	......	....	....	12. 5	....	....	E.
3428-3550	580 R	Timothy Sullivan	105, 660	25, 171	904	740	497	34	50	11. 74	13	95	E.
4409-4432	603 R	The J. S. McTighe B. C. & I. I. Co.	24, 000	......	......	......	......	....	....	18. 2	....	....	F.
4432-4452	604 R	Ernest Hyner	106, 774	84, 067	9, 652	......	(*a*)	....	(*a*)	27. 5	19	225	N.
4452-4472	......	.....do	136, 297	87, 568	14, 612	655	*b* 468	35	*b* 42	27. 5	19	225	N.
4472-4492	604 R	.....do	114, 504	63, 414	12, 377	......	(*c*)	....	(*c*)	27. 5	19	225	N.
4492-4507	604 R	.....do	88, 564	71, 625	5, 971	2, 472	*d* 1, 650	25	*d* 87	27. 5	19	225	N.
4507-4540	605 R	The J. S. McTighe B. C. & I. I. Co.	47, 500	......	......	......	......	....	....	23	....	....	E.
4540-4551	606 R	Arnold, DeGaris & Co.	83, 827	62, 247	12, 842	......	(*e*)	....	(*e*)	36. 75	22	400	N.
4551-4570	606 R	he J. S. McTighe B. C. & I. I. Co.	28, 000	......	......	......	......	....	....	19. 5	....	....	E.

a 8,755 wheelbarrows; 9.6 cubic yards per barrow.
b Also 10,478 wheelbarrows; 6.4 cubic yards per barrow.
c 10,511 wheelbarrows; 6 cubic yards per barrow.
d Also 1,575 wheelbarrows; 5.1 cubic yards per barrow.
e 9.934 wheelbarrows; 6.2 cubic yards per barrow.

Respectfully submitted.

W. S. BROWN, *Assistant Engineer.*

Cost of levees in Lower Yazoo Levee district, built and enlarged by the United States, from 1882 to May 1, 1898.

Year built.	Name of levee.	Location on inch-to-mile map.	Built by—	Cubic yards.	Cost including extra work.
1882 to Apr. 30, 1897.	Levee construction			6,962,600	$1,207,439.18
Do	High-water protection, repairs, and engineering expenses.				220,480.44
1897	Station 0 to 100	367 L	Ernest Hyner	125,432	15,100.63
1897	Station 100 to 200	369 L	do	139,068	15,989.84
1897	Station 200 to 300	370 L	C. A. Winter	115,409	15,274.00
1897-98	Station 300 to 400	372 L	Ernest Hyner	81,563	[a] 9,542.87
1897	Station 400 to 500	374 L	do	107,824	12,508.16
1897-98	Station 500 to 600	376 L	E. B. Mantle	85,945	[a] 9,282.06
1897	Station 600 to 700	377 L	L. C. Dulaney	56,436	5,209.04
1897	Station 700 to 800	378 L	T. S. Aderholdt	49,491	5,435.04
1897	Station 800 to 900	378 L	do	102,324	10,477.97
1897	Station 900 to 1000	379 L	W. A. Shippey	86,243	15,708.03
1897	Station 1200 to 1300	395 L	T. S. Aderholdt	63,467	7,002.94
1897	Station 1300 to 1400	396 L	P. F. Lamb	63,793	7,974.13
1897	Station 1400 to 1500	398 L	Robert Johnsen	67,792	9,740.71
1897	Station 1500 to 1600	399 L	Ernest Hyner	85,416	10,875.35
1897	Station 1600 to 1700	401 L	C. A. Winter	58,575	6,355.43
1897	Station 1700 to 1800	401 L	J. B. Lewis	59,921	6,830.19
1897	Station 1800 to 1900	403 L	W. A. Shippey	89,052	10,502.56
1897	Station 1900 to 2000	405 L	Ernest Hyner	106,773	12,900.65
1897-98	Station 2000 to 2066	405 L	W. M. Bates & Co	78,735	10,179.74
1897-98	Station 999 to 1018	380 L	McIntyre & Howard	75,883	9,105.96
1897-98	Station 1018 to 1034	380 L	do	41,615	[a] 4,494.42
1897-98	Station 1034 to 1051a	380 L	do	66,387	7,966.44
1897-98	Station 2620 to 2700	418 L	Green Clay	84,112	11,439.23
1897-98	Station 2700 to 2800	419 L	McCadden & Roach	38,593	[a] 4,247.93
1897-98	Station 2959 to 3000	431 L	Ernest Hyner	30,693	3,683.16
1898	Station 3000 to 3100	431 L	do	14,768	[a] 1,594.94
1897-98	Station 3100 to 3187	433 L	do	58,102	[a] 8,366.69
1898	Station 3187 to 3201	434 L	Robert Johnsen	81,803	11,388.86
1897-98	Station 3201 to 3215	434 L	do	112,572	11,760.11
1897	Station 3215 to 3239a	434 L	do	94,576	13,940.50
1897-98	Station 3225b to 3282	435 L	McLeod & McCarten	65,937	[a] 7,981.68
1897-98	Station 3282 to 3306	436 L	W. M. Bates & Co	72,915	9,114.38
1898	Station 3306 to 3329	436 L	James H. Cary	63,857	[a] 7,183.91
1898	Station 3329 to 3360	436 L	McIntyre & Howard	15,764	[a] 1,841.55
1897-98	Station 3360 to 3400	436 L	P. F. Lamb	70,105	[a] 8,517.75
1897-98	Station 3400 to 3440	436 L	McLeod & McCarten	125,850	[a] 14,384.66
1897-98	Station 3440 to 3469	436 L	J. S. McTighe B. C. & I. I. Co.	156,201	26,444.82
1897-98	Station 3469 to 3514	436 L	McLeod & McCarten	121,554	[a] 13,893.63
1898	Station 4200 to 4300	460 L	Ben Talley	56,772	[a] 7,127.72
1897-98	Station 4300 to 4400	475 L	McCadden & Roach	78,530	[a] 9,470.72
1898	Station 4400 to 4500	476 L	Timothy Sullivan	7,638	[a] 890.21
1898	Station 4500 to 4570	477 L	do	61,608	6,622.86
1897-98	Station 0 to 60	479 L	do	47,502	[a] 4,595.82
1897-98	Station 790 to 811	492 L	do	88,790	12,299.06
1897-98	Station 3551 to 3601	545 L	L. C. Dulaney	105,608	10,507.99
1897-98	Station 4868 to 4913	569 L	Ben Talley	125,601	17,960.94
1897-98	Station 4913 to 4958	569 L	do	139,108	19,892.43
1897-98	Station 4958 to 5012	569 L	do	128,145	16,274.42
1897-98	Station 595 to 625	377 L	H. F. Watkins	88,646	7,654.01
1897	Station 625 to 641	377 L	do	44,827	4,634,42
1897-98	Station 1037b to 1200	392 L	Stone & Stansell	77,779	[a] 10,836.17
1898	Station 100 to 150	480 L	T. Mike	2,732	[a] 239.49
1898	Station 150 to 200	481 L	do	13,505	[a] 1,148.60
1897-98	Station 6 to 100	479 L	C. A. Winter	23,206	[a] 2,078.10
1898	Station 100 to 200	480 L	John G. Sessions	14,605	[a] 1,311.82
	High-water protection, repairs, and engineering expenses, May 1, 1897, to May 1, 1898.				[b] 93,524.20
	Total cubic yards to May 1, 1898.			11,080,748	
	Total expenditures to May 1, 1898.				2,028,778.56

[a] Unfinished.

[b] Includes $10,000 apportioned from allotment of $30,000 for "Preservation of works."

UPPER TENSAS LEVEE DISTRICT.

Cost of levees in Arkansas, built and enlarged by the United States, from 1882 to May 1, 1898.

Year built.	Name of levee.	Location inch-to-mile map.	Built by—	Cubic yards.	Cost, including extra work.
1882 to Apr. 30, 1897.	Levee construction			10,068,839.2	$1,659,584.79
Do	High-water protection, repairs, and engineering expenses.				371,621.34
1897	Stations 0 to 120	(*a*)	J. M. Whitehill	44,662	5,597.35
1897-98	Stations 1080 to 1200	441 R	do	72,768	*b* 9,028.90
1897-98	Stations 1510 to 1630	451 R	J. B. Lewis	75,216	10,557.91
1897-98	Stations 120 to 250	405 R	Jas. H. Cary	59,345	8,901.75
1897	Stations 1630 to 1730	452 R	Arnold & De Garis	54,424	10,963.57
1897	Stations 216 to 388	485 R	do	52,465	10,287.21
1897	Stations 388 to 462	487 R	C. A. Winter	38,742	9,042.71
1897	Stations 1384 to 1399	506 R	Jas. H. Cary	15,227	3,806.75
1897	Stations 1660 to 1845	510 R	Jno. G. Sessions	61,448	8,542.24
1897-98	Stations 1845 to 2010	515 R	W. M. Bates & Co	69,086	10,487.01
1897	Stations 2010 to 2108	517 R	L. C. Dresbach	53,112	7,979.68
1898	Stations 180 to 230	425 R	J. M. Whitehill	14,838	*b* 1,736.28
1897-98	Stations 1810 to 1941	466 R	J. V. Daugherty	85,435	*b* 12,302.64
1898	Stations 3645 to 3758	508 R	C. Meyer	5,377	1,075.40
	High-water protection, repairs, and engineering expenses, May 1, 1897, to May 1, 1898.				*c* 33,738.44
	Total cubic yards to May 1, 1898.			10,770,984.2	
	Total expenditures to May 1, 1898.				2,175,253.97

a Amos Bayou line.
b Unfinished.
c Includes $10,000 expended from allotment of $30,000 for "Preservation of works."

Cost of levees in Louisiana, built and enlarged by the United States, from 1882 to May 1, 1898.

Year built.	Name of levee.	Location, inch-to-mile map.	Built by—	Cubic yards.	Cost, including extra work.
1882 to Apr. 30, 1897.	Levee construction			5,119,377.2	$863,480.04
Do	High-water protection, repairs, and engineering expenses.				179,761.14
1897-98	Stations 0 to 256	520 R	Arnold & De Garis	185,570.8	*a* 14,934.35
1897-98	Stations 756 to 851	528 R	F. M. McLaughlin	62,277.5	9,176.62
1897	Stations 851 to 930	529 R	Robt. Nicholson	45,814.1	5,004.23
1897	Stations 1459 to 1636	542 R	do	60,386.2	6,581.95
1897	Stations 2286 to 2367	560 R	do	32,894.1	3,867.37
1898	Stations 3428 to 3550	583 R	Timothy Sullivan	25,171	*a* 2,659.57
1897-98	Stations 4432 to 4452	603 R	Ernest Hyner	77,810	*a* 19,257.98
1898	Stations 4452 to 4472	603 R	do	87,568	*a* 21,673.08
1898	Stations 4472 to 4492	604 R	do	63,414	*a* 15,694.97
1898	Stations 4492 to 4507	604 R	do	71,625	*a* 17,727.19
1898	Stations 4540 to 4551	605 R	Arnold, De Garis & Co.	39,301	*a* 12,998.81
	High-water protection, repairs, and engineering expenses, May 1, 1897, to May 1, 1898.				*b* 29,013.73
	Total cubic yards to May 1, 1898.			5,821,208.9	
	Total expenditures to May 1, 1898.				1,201,831.03

a Unfinished.
b Includes $10,000 expended from allotment of $30,000 for "Preservation of works."

Financial statement.

ASHBROOK NECK.

Balance unexpended June 30, 1897	$11,010.09
Allotted during year	8,944.44
Total	19,954.53
Expended to June 30, 1898	12,277.48
Balance unexpended June 30, 1898 (in hand and available)	7,677.05
Expenditures apportioned:	
Material for construction	1,236.49
Labor on construction	4,440.21
Cost and care of plant, outfit, and supplies	2,674.40
Towage and steamer expenses	1,379.36
Administration and office expenses	862.88
Subsistence	1,669.43
Miscellaneous	14.71
Total	12,277.48
Amount that can be profitably expended during fiscal year ending June 30, 1900, for maintenance	30,000.00

AT GREENVILLE, MISS.

Balance unexpended June 30, 1897	$47,026.69
Received by transfer from Lake Providence Reach	50,000.00
Total	97,026.69
Expended to June 30, 1898	95,061.12
Balance unexpended June 30, 1898 (in hand and available)	1,965.57
Expenditures apportioned:	
Material for construction	47,255.75
Labor on construction and towage expenses	39,241.07
Repairs to plant, outfit, and supplies	1,208.94
Administration and office expenses	2,629.64
Subsistence	4,725.72
Total	95,061.12
Amount that can be profitably expended during fiscal year ending June 30, 1900, for maintenance	100,000.00

LAKE PROVIDENCE REACH.

Balance unexpended June 30, 1897	$4,481.91
Allotted during year	14,750.00
Total	19,231.91
Expended to June 30, 1898	4,837.67
Balance unexpended and available June 30, 1898	14,394.24
In Treasury	8,750.00
In hand	5,644.24
	14,394.24
Expenditures apportioned:	
Cost and care of plant, repairs, outfit, and supplies	3,732.82
Administration, stationery, and office expenses	223.65
Subsistence	865.45
Miscellaneous	15.75
Total	4,837.67
Amount that can be profitably expended during fiscal year ending June 30, 1900, for maintenance	50,000.00

DELTA POINT.

Allotted during year	$6,000.00
Expended to June 30, 1898	3,254.28
Balance unexpended June 30, 1898 (in hand and available)	2,745.72
Expenditures apportioned:	
Labor on construction	621.25
Towage and steamer expenses	1,451.88
Administration and office expenses	943.89
Subsistence	236.16
Miscellaneous	1.10
Total	3,254.28
Amount that can be profitably expended during fiscal year ending June 30, 1900, for maintenance	50,000.00

IMPROVING HARBOR AT VICKSBURG, MISS.

Balance unexpended June 30, 1897	$2,972.03
Expended to June 30, 1898	2,972.03
Expenditures apportioned:	
Labor on construction	203.29
Cost of plant and supplies	137.56
Administration, inspection, and office expenses	2,229.01
Subsistence	402.17
Total	2,972.03

LOWER YAZOO LEVEE DISTRICT.

Balance unexpended June 30, 1897	$78,303.64
Allotted during year	661,300.00
Total	739,603.64
Expended to June 30, 1898	597,497.62
Balance unexpended June 30, 1898	142,106.02
In Treasury	116,300.00
In hand	25,806.02
	142,106.02
Amount covered by existing contracts and liabilities	142,106.02
Expenditures apportioned:	
Levee construction	523,563.89
Engineering and office expenses, high-water protection, and repairs	73,933.73
Total	597,497.62
Amount that can be profitably expended during fiscal year ending June 30, 1900	500,000.00

UPPER TENSAS LEVEE DISTRICT.

Balance unexpended June 30, 1897	$111,176.02
Allotted during year	363,150.00
Total	474,326.02
Expended to June 30, 1898	294,896.01
Balance unexpended June 30, 1898	179,430.01

In Treasury	$146,400.00
In hand	33,030.01
	179,430.01
Amount covered by existing contracts and liabilities	156,100.00
Balance available June 30, 1898	23,330.01

Expenditures apportioned:	
Levee construction	254,590.84
Engineering and office expenses, high-water protection, and repairs	40,305.17
Total	294,896.01
Amount that can be profitably expended during fiscal year ending June 30, 1900	500,000.00

SURVEYS, GAUGES, AND OBSERVATIONS.

Balance unexpended June 30, 1897	$4,613.64
Expended to June 30, 1898	4,365.23
Balance unexpended June 30, 1898	248.41
In hand	248.41
Amount covered by outstanding liabilities	200.00
Balance available June 30, 1898	48.41

Expenditures apportioned:	
Pay of surveyor and assistants	2,873.67
Steamer expenses	1,113.89
Outfit, material, and stationery	115.24
Subsistence	234.61
Miscellaneous	27.82
Total	4,365.23
Amount that can be profitably expended during fiscal year ending June 30, 1900	10,000.00

STONE.

Balance unexpended June 30, 1897	$15,031.70
Allotted during year	30,000.00
Amount received on account overpayment	.04
Total	45,031.74
Expended to June 30, 1898	35,944.56
Balance unexpended June 30, 1898	9,087.18
In Treasury	6,000.00
In hand	3,087.18
	9,087.18
Amount covered by existing contracts and liabilities	4,000 00
Balance available June 30, 1898	5,087.18

Expenditures apportioned:	
Stone	10,803.80
Towing stone and unloading same	20,033.64
Cost and care of plant, outfit, and supplies	1,496.95
Administration and office expenses	1,491.94
Subsistence	2,118,23
Total	35,944.56
Amount that can be profitably expended during fiscal year ending June 30, 1900	60,000.00

PLANT.

Balance unexpended June 30, 1897	$25.44
Allotted during year	75,000.00
Amount received by deposit account overpayment	10.00
Total	75,035.44
Expended to June 30, 1898	26,056.69
Balance unexpended June 30, 1898	48,978.75
In Treasury	45,000.00
In hand	3,978.75
	48,978.75
Amount covered by existing contracts and liabilities	40,450.00
Balance available June 30, 1898	8,528.75
Expenditures apportioned:	
Material for repairs	639.29
Labor on repairs and care of plant	17,862.24
Outfit and supplies	974.82
Administration and office expenses	3,108.16
Subsistence	3,461.65
Miscellaneous	10.53
Total	26,056.69
Amount that can be profitably expended during fiscal year ending June 30, 1900	35,000.00

Abstract of proposals for levee work in Lower Yazoo Levee district received and opened by Capt. H. C. Newcomer, Corps of Engineers, August 11, 1897.

No.	Name of bidder.	Stations 999 to 1018 (380 L).	Stations 1018 to 1034 (380 L).	Stations 1034 to 1051a (380 L).	Stations 1037b to 1200 (392 L); date of completion. a		Stations 2620 to 2700 (418 L); date of completion.		Stations 2700 to 2800 (419 L); date of completion.	
					Mar. 1, 1898.	Jan. 1, 1899.	Mar. 1, 1898.	Jan. 1, 1899.	Mar. 1, 1898.	Jan. 1, 1899.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
2	Arnold & De Garis					17.75		15.5		18.25
3	Martin Jennings & Co.	13.375	13.875	13.25			16.625	15		19
4	H. F. Watkins	15	15	15				15.9		16.9
7	Shippey & Johnsen	16	16	15	19	17		20		16
8	Reese Thomas	13.25	13.25	13.25	21	17				
10	Jno. G. Sessions						17.20	16.20	19.7	18
11	W. L. Withers & Co								21.5	19.75
12	J. V. Daugherty						15	14	16.5	15.5
13	J. B. Lewis							14.72		15
14	Green Clay						15.85	b 13.6	16.9	14.4
15	Timothy Sullivan	13.98	14.5	13		18.97		15.5		15.5
18	W. M. Bates & Co						15.75	13.75	16.75	15.75
19	The J. S. McTighe B. C. and L I. Co	14.53	14.53	14.53	24.45	20.45	22.96	17.87	19.19	16.24
21	C. A. Winter									16.98
25	P. F. Lamb	13.25					20		20	
27	Ernest Hyner				19.97	18.97	15.47	14.47	15.47	14.47
28	McCadden & Rosch							14.45		b 12.23
29	McIntyre & Howard	b 12	b 12	b 12			16.48		15.74	
30	Jno. Scott & Sons						24	20	24	20
32	Jas. H. Cary									13
34	T. S. Aderholdt	14.125	14.25	14.5		21.5		15.25		20

a Stations 1037b–1200, all bids rejected and work readvertised.

b Accepted.

Abstract of proposals for levee work in Lower Yazoo Levee district received and opened by Capt. H. C. Newcomer, Corps of Engineers, August 11, 1897—Continued.

No.	Name of bidder.	Stations 2800 to 2880 (420 L); date of completion.		Stations 2959 to 3000 (431 L); date of completion.		Stations 3000 to 3100 (431 L); date of completion.		Stations 3100 to 3187 (433 L); date of completion.		Stations 3187 to 3201 (434 L).	Stations 3201 to 3215 (434 L).
		Mar. 1, 1898.	Jan. 1, 1899.	Mar. 1, 1898.	Jan. 1, 1899.	Mar. 1, 1898.	Jan. 1, 1899.	Mar. 1, 1898.	Jan. 1, 1899.		
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
2	Arnold & De Garis		14.75				16.7		16.25		
3	Martin Jennings & Co.	15.5	15.5	14.75	13.25		16.25		18		
4	H. F. Watkins		13.49		12.96		18.95		18.95		
6	Robt. Johnsen									*a* 14.74	*a* 14.74
7	Shippey & Johnsen		15		18		13		21		
10	Jno. G. Sessions	18.45	16.25	15.7	15	20	16.9	25	17.9		
11	W. L. Withers & Co.			15	14	21.5	19.5				
12	J. V. Daugherty	16	15	15	14	17	16	17.5	16.5		
13	J. B. Lewis		13.7		13		17.75		18		
14	Green Clay	15.87	13.49	14.25	13					18.75	
15	Timothy Sullivan		15.5		13.5		13.5		17		
18	W. M. Bates & Co	15	13	16	14.25	17.5	15.75	18	16		
19	The J. S. McTighe B. C. and I. I. Co	21.24	16.5	13.99	12.99	18.1	15.97	20.26	16.49	19.24	38.24
20	Ben Talley			19	13	19	18				
21	C. A. Winter		14.7				16.2		15.2		
22	A. & J. Wynn			15	13.875						
25	P. F. Lamb	18		15			18				
26	McLeod & McCarten	19	13.97	17	12.87						
27	Ernest Hyner	14	*a* 12	14	*a* 12	14	*a* 12	*a* 16	15.5	18	18
28	McCadden & Roach		13.24		11.2		16		17.9		
29	McIntyre & Howard									18.74	18.99
30	Jno. Scott & Sons	21	17	19	15	22	18	28	24	17	17
32	Jas. H. Cary		13		14		14		13.5		
34	T. S. Aderholdt		15.75		14		17		18.125		

No.	Name of bidder.	Stations 3215 to 3239a (434 L).	Stations 3225b to 3282 (435 L); date of completion.		Stations 3282 to 3329 (436 L).	Stations 3329 to 3360 (436 L).	Stations 3360 to 3400 (436 L).	Stations 3400 to 3440 (436 L).	Stations 3440 to 3469 (436 L).	Stations 3469 to 3514 (436 L).
			Mar. 1, 1898.	Jan. 1, 1899.						
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
2	Arnold & De Garis			17						
3	Martin Jennings & Co.				16					
4	H. F. Watkins	14		14.74	13.94	14.94	14.94			
6	Robt. Johnsen	*a* 14 74								
7	Shippey & Johnsen				13.49	13.99				
10	Jno. G. Sessions	15.9	20	18.2	13.88	17	14.7	15.45	18.45	17.35
11	W. L. Withers & Co	15.5								
12	J. V. Daugherty		17.5	16.5	14	15	15.75	15.5	20	17.5
13	J. B. Lewis			17	14	16	16	16		
14	Green Clay	15.8	17.45	16	14.75					
15	Timothy Sullivan			15	14	14.5	14.25	14.5	20	13.87
18	W. M. Bates & Co		18	16	*a* 12.5	13	15	14.5	18	16
19	The J. S. McTighe B. C. and I. I. Co.	17.93	22.1	17.72	13.98	13.99	13.99	13.99	*a* 16.93	16.23
21	C. A. Winter	14.15		14.7	13.15	15.98	15		18.7	16.2
22	A. & J. Wynn			15.5						
25	P. F. Lamb		19		13.5		*a* 13.5			
26	McLeod & McCarten		19.7	*a* 13.45	12.70			*a* 12.7		*a* 12.7
27	Ernest Hyner	18	18	17						
28	McCadden & Roach			13.6						
29	McIntyre & Howard	18			12.98	*a* 12.98	13.74	13.94	17.99	15.74
30	Jno. Scott & Sons	17	20	16	14	14	14	14	14	14
32	Jas. H. Carey	13		16	*a* 12.5	13	14.5	17.5	17	
34	T. S. Aderholdt			17.5						

a Accepted.

Abstract of proposals for levee work in Lower Yazoo Levee district received and opened by Capt. H. C. Newcomer, Corps of Engineers, August 11, 1897—Continued.

No.	Name of bidder.	Stations 3880 to 3930 (445 L); date of completion.		Stations 4150 to 4200 (459 L); date of completion.		Stations 4200 to 4300 (460 L); date of completion.		Stations 4300 to 4400 (475 L); date of completion.		Stations 4400 to 4500 (476 L); date of completion.	
		Mar. 1, 1898.	Jan. 1, 1899.	Mar. 1, 1898.	Jan. 1, 1899.	Mar 1, 1898.	Jan. 1, 1899.	Mar. 1, 1898.	Jan. 1, 1899.	Mar. 1, 1898.	Jan. 1, 1899.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	Jno. A. Cannon & Co	......	......	22	22	17.875	17.625	18.99	13.5	16.875	17
2	Arnold & De Garis	......	a16.1	......	a15.75	......	18	......	18.25	......	17
7	Shippey & Johnsen	......	......	......	......	......	15	......	15	......	15
10	Jno. G. Sessions	......	......	......	......	25	18.9	......	......	......	......
12	J. V. Daugherty	18.5	17.5	25	24	25	24	19	18	16	15
13	J. B. Lewis	......	16.7	......	16.9	......	16.875	......	16.875	......	17.875
15	Timothy Sullivan	......	......	......	......	......	19.75	......	13.95	......	a12.95
18	W. M. Bates & Co	19	17.25	24	22.5	24	22.5	19.75	17.75	15.5	14
19	The J. S. McTighe B. C. and I. I. Co	22.1	17.95	22	17.93	20.12	17.26	19.95	16.76	18.4	15.69
20	Ben Talley	......	......	......	......	19	a13.95	19	13.95	......	......
21	C. A. Winter	......	17.50	......	16.125	......	15.75	......	14.75	......	......
22	A. & J. Wynn	......	......	......	......	......	......	......	......	16.875	......
27	Ernest Hyner	......	......	17.97	16.97	16.47	15.97	14.47	13.97	......	......
28	McCadden & Roach	......	......	......	16.4	......	15.9	......	a13.4	......	14.4
29	McIntyre & Howard	......	......	......	......	23.98	......	19.49	......	15.49	......
30	Jno. Scott & Sons	30	26	30	26	30	26	25	20	27	22
32	Jas. H Cary	......	......	......	......	......	......	......	15	......	15

No.	Name of bidder.	Stations 4500 to 4570 (477 L); date of completion.		Stations 0 to 60 (479 L); date of completion.		Stations 790 to 811 (492 L).	Stations 3551 to 3601 (545 L).	Stations 4868 to 4913 (569 L).	Stations 4913 to 4958 (569 L).	Stations 4958 to 5012 (569 L).
		Mar. 1, 1898.	Jan. 1, 1899.	Mar. 1, 1898.	Jan. 1, 1899.					
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	Jno. A. Cannon & Co	18.74	13.74	......	......	......	......	......	......	......
2	Arnold & De Garis	......	14.75	......	15.25	......	......	......	......	......
3	Martin Jennings & Co	......	......	......	......	......	11.875	......	......	18.25
4	H. F. Watkins	......	......	......	......	......	14.9	......	......	......
10	Jno. G. Sessions	......	......	22	18	17.7	13.7	19	20	17
12	J. V. Daugherty	16	15	......	......	......	......	16	20	15
13	J. B. Lewis	......	15.375	......	16	......	......	......	......	......
15	Timothy Sullivan	......	a10.75	......	a10.75	a13.97	13.98	......	......	......
16	Chas. J. Ingersoll	......	......	......	......	......	10.47	......	......	......
18	W. M. Bates & Co	16	14	15.5	13.5	......	15	16	20	15
19	The J. S. McTighe B. C. and I. I. Co	18.27	15.98	18.99	16.25	17.2	13.93	15.5	16.5	15.3
20	Ben Talley	......	......	18	16	......	......	a14.3	a14.3	a12.7
21	C. A. Winter	15	13.7	16.375	15	19.2	15.2	......	......	16.7
23	L. C. Dulaney	......	......	......	......	......	a9.95	......	......	14.93
26	McLeod & McCarten	13.97	11.09	20	11.87	......	......	......	......	......
28	McCadden & Roach	......	......	......	11.4	......	......	......	......	......
29	McIntyre & Howard	15.49	......	......	......	......	14.98	21	23	19
30	Jno. Scott & Sons	29	24	......	......	16.75	15	18	13	18
32	Jas. H. Cary	......	11.5	......	......	15	12.5	15	16	15.5

a Accepted.

Abstract of proposals for levee work in Upper Tensas Levee district, received and opened by Capt. H. C. Newcomer, Corps of Engineers, August 11, 1897.

No.	Name of bidder.	Stations 120 to 250 (405 R).	Stations 180 to 230 (425 R); date of completion.		Stations 1740 to 1780 (452 R). a				Stations 1810 to 1941 (466 R); date of completion.	
			Mar. 1, 1898.	Jan. 1, 1899.	Date of completion, Mar. 1, 1898.		Date of completion, Jan. 1, 1899.		Mar. 1, 1898.	Jan. 1, 1899.
					Riverside enlargement.	Landside enlargement.	Riverside enlargement.	Landside enlargement.		
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
2	Arnold & De Garis			15				19		16.5
5	Geo. A. McBain	19.95		14.45				21.74		20.74
9	J. M. Whitehill	16.25	*b* 13	11						
12	J. V. Daugherty		15.5	14.5					*b* 16	15
13	J. B. Lewis	16	14.5	13.5	31			22		16.625
18	W. M. Bates & Co.	15.5	16.5	14.5	27	21.5	25	19.25	20.5	18.5
19	The J. S. McTighe B. C. & I. I. Co.	17.37	14.1	12.5	35		28		19.9	16.25
21	C. A. Winter							22		18.7
23	L. C. Dulaney		22	10.99						
32	Jas. H. Cary	*b* 15	15				22			22
33	Wm. M. Forrest	18	14							

No.	Name of bidder.	Stations 3065 to 3100 (496 R); date of completion.		Stations 3328 to 3428 (582 R); date of completion.		Stations 3428 to 3550 (583 R); date of completion.		Stations 4409 to 4432 (603 R); date of completion.	
		Mar. 1, 1898.	Jan. 1, 1899.	Mar. 1, 1898.	Jan. 1, 1899.	Mar. 1, 1898.	Jan. 1, 1899.	Mar. 1, 1898.	Jan. 1, 1899.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
2	Arnold & De Garis		15.75		16.5		16.5		
10	Jno. G. Sessions	25	17.9	20	18	19	17	50	30
12	J. V. Dangherty	16	15	17.5	16.5	16.5	15.5		
13	J. B. Lewis		19.75						
15	Timothy Sullivan				15.97		*a* 11.74		
17	Robt. Nicholson			25	19	20	14.08		
18	W. M. Bates & Co	16	*a* 14	17	15	16	14		
19	The J. S. McTighe B. C. & I. I. Co	17.28	15.98	26	18	25.93	19	*b* 18.2	15.9
24	F. M. McLaughlin			20	14.83	18	13		
30	Jno. Scott & Sons			20	16	20	16	45	35
35	J. C. Hodge				*a* 12.5		12.5		

No.	Name of bidder.	Stations 4432 to 4452 (603 R).	Stations 4452 to 4472 (603 R).	Stations 4472 to 4492 (604 R).	Stations 4492 to 4507 (604 R).	Stations 4507 to 4540 (604 R); date of completion.		Stations 4540 to 4551 (605 R).	Stations 4551 to 4570 (605 R); date of completion.	
						Mar. 1, 1898.	Jan. 1, 1899.		Mar. 1, 1898.	Jan. 1, 1899.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
10	Jno. G. Sessions					75	35		75	35
19	The J. S. McTighe B. C. & I. I. Co.	38.35	38.35	38.35	38.35	26	23	38.35	23	19.5
30	Jno. Scott & Sons	33	33	33	33			40		
35	J. C. Hodge			24						

a Stations 1740 to 1780, all bids rejected and work readvertised. *b* Accepted.

All bids rejected and work readvertised.

Abstract of informal proposals for levee work in Lower Yazoo Levee district, received and opened by Capt. H. C. Newcomer, Corps of Engineers, August 31, 1897.

No.	Name of bidder.	Stations 595 to 625 (377 L).	Stations 625 to 641 (377 L).	Stations 1037b to 1200 (892 L); date of completion.		Stations 60 to 100 (480 L); date of completion.	
				Mar. 1, 1898.	Jan. 1, 1899.	Mar. 1, 1898.	Jan. 1, 1899.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	McCadden & Roach						14.45
2	Timothy Sullivan	15	15	20.5	17.5	14.75	10.5
3	Jno. G. Sessions						11.74
4	L. C. Dulaney				17.45		a 10.23
5	Wm. M. Forrest	14.85	14.74				
6	T. Mike						10.24
8	The J. S. McTighe B. C. & I. I. Co.						12.24
9	H. F. Watkins	a 10.45	a 10.45			13	10.40
10	Shippey & Johnsen	13.24	13.24	19.49	15.94	13.99	10.99
11	W. M. Bates & Co					16	10.5
13	Stone & Stansell				a 15.48		12
15	Southern Planting and Improvement Co	13.95	14.25	25	17.97	19	10.84
16	C. A. Winter				15.625		11.375
17	Jno. A. Cannon					16.74	14.74
18	T. S. Aderholdt	13.9	13.2		21		
19	J. C. Neely	14.875	14.875				
21	Martin Jennings & Co				16		13.875
22	McLeod & McCarten					19.7	11.7
24	Geo. A. McBain						12.74
26	Arnold & De Garis				16.2		12.8
27	P. F. Lamb	14.25	14.25	20.75	18	17.25	13.5
28	J. B. Lewis						11.75
29	L. C. Dresbach	12.4	13			13.5	12.24
30	Ben Talley			27	16.2	17	10.95
31	Ernest Hyner	12.97	12.97				12

No.	Name of bidder.	Stations 100 to 150 (480 L); date of completion.		Stations 150 to 200 (481 L); date of completion.		Stations 6 to 100 (479 L).	Stations 100 to 200 (480 L).
		Mar. 1, 1898.	Jan. 1, 1899.	Mar. 1, 1898.	Jan. 1, 1899.		
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	McCadden & Roach		14.45		14.45		
2	Timothy Sullivan	14.5	10.5	14.5	10.5	14.5	14.5
3	Jno. G. Sessions		11.74		11.24	9.98	a 9.98
4	L. C. Dulaney		11.25		11.25	9.99	9.99
6	T. Mike		a 9.74		a 9.45	12.24	12.24
8	The J. S. McTighe B. C. & I. I. Co.		12.24		12.24		
9	H. F. Watkins	13	10.4	13	10.4	10	10
10	Shippey & Johnsen	13.99	10.99	13.99	10.99	13.99	13.99
11	W. M. Bates & Co	16.5	11	17	11.5	10	10
13	Stone & Stansell		12		12	12	12
15	Southern Planting and Improvement Co	19	10.84	21	12.2	10.15	10.15
16	C. A. Winter		12.125		12.125	a 9.95	10.625
17	Jno. A. Cannon	15.875	14.24	14.99	11.94	12.94	12.94
20	John Burke					11	11
21	Martin Jennings & Co		13.875		14	12.875	12.375
22	McLeod & McCarten	19.7	11.7	19.7	11.7		
24	Geo. A. McBain		12.74		12.74		10.74
26	Arnold & DeGaris		12.8		12.8		11
27	P. F. Lamb	17.25	13.5	17.25	13.5	13.5	13.5
28	J. B. Lewis		11		11.75	10.9	10.9
29	L. C. Dresbach		13.24		13	11.49	11.49
30	Ben Talley	17	10.95	17	10.95	14.24	14.24
31	Ernest Hyner		12		12		

a Accepted.

Abstract of informal proposals for levee work in Upper Tensas Levee district, received and opened by Capt. H. C. Newcomer, Corps of Engineers, August 31, 1897.

No.	Name of bidder.	Stations 420 to 484 (427 R); date of completion.		Stations 630 to 660 (430 R); date of completion.		Stations 780 to 800 (432 R); date of completion.			Stations 1490 to 1510 (449 R); date of completion.	
							Jan. 1, 1899.			
		Mar. 1, 1898.	Jan. 1, 1899.	Mar. 1, 1898.	Jan. 1, 1899.	Mar. 1, 1898.	River-side enlargement.	Land-side enlargement.	Mar. 1, 1898.	Jan. 1, 1899.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
2	Timothy Sullivan		19.75							
4	L. C. Dulaney		15.75		17.45		15			
5	Wm. M. Forrest	30	21	29	21	29	21			
7	J. M. Whitehill		18		a12		a10			
9	H. F. Watkins		15		15.7			12		
10	Shippey & Johnsen		16		15.99		17.94			15.9
11	W. M. Bates & Co	18	a13.5		18			25		
15	Southern Planting and Imp. Co		17		21		17			
16	C. A. Winter		13.625							a14.375
17	Jno. A. Cannon				24				24	24
21	Martin Jennings & Co.		22		16		25			25
24	Geo. A. McBain				21.375		21.375		23	
26	Arnold & DeGaris		15.7		18.5					
28	J. B. Lewis		14		16		14			17.5

No.	Name of bidder.	Stations 1740 to 1780 (452 R); date of completion.			Stations 3160 to 3185 (498 R); date of completion.		Stations 4432 to 4452 (603 R).	Stations 4452 to 4472 (603 R).	Stations 4472 to 4492 (604 R).	Stations 4492 to 4507 (604 R).	Stations 4540 to 4551 (605 R).
			Jan. 1, 1899.								
		Mar. 1, 1898.	River side enlargement.	Land side enlargement.	Mar. 1, 1898.	Jan. 1, 1899.					
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
2	Timothy Sullivan		19.75								
10	Shippey & Johnsen		a15.9			15.44	30.99	30.99	30.99	30.99	33
11	W. M. Bates & Co				18	a15					
12	Grigsby Con. Co						29	29	29	29	
14	F. L. Maxwell						30.5	31.5	32.5		
16	C. A. Winter		18.7			16.625					
17	John A. Cannon		24			24					
21	Martin Jennings & Co.		20			22					
23	Dameron & White						30	30	30	30	
24	Geo. A. McBain			19.375							
25	Arnold, De Garis & Co						28.75	28.75	28.75	28.75	a36.75
26	Arnold & De Garis		18.25								
28	J. B. Lewis		18.75								
31	Ernest Hyner						a27.5	a27.5	a27.5	a27.5	
32	Robt. Nicholson						28.75	28.75	28.75	28.75	

a Accepted.

Abstract of informal proposals for levee banquette work in Lower Yazoo Levee district, north of Greenville, received and opened by Capt. H. C. Newcomer, Corps of Engineers, May 14, 1898.

No.	Name of bidder.	Stations 900 to 993 (379 L).	Stations 1037 to 1058 (392 L).	Stations 1202 to 1235 (394 L).	Stations 1340 to 1460 (397 L).	Stations 1491 to 1530 (399 L).	Stations 1810 to 1830 (402 L).	Stations 1870 to 1980 (403 L).	Stations 2005 to 2066 (404 L).	Stations 3166 to 3186 (433 L).
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	Green Clay			16	16	16		15		17
2	John G. Sessions	12.98	11.98	11.98	13.24	11.98	13.98	12.78	12.73	13.98
3	J. C. Neely	*a* 8.85								
4	Wm. M. Forrest	10.25	10.5		12.99	10.5	22.5			
5	Stone & Stansell	10.49	10.49	10.49	10.49	10.49	10.49	10.49	10.49	
6	M. McTighe	12.5	12.5	13.5	12.25	13	12	11.78	11.78	15
7	C. A. Winter	11.875	12.875	12.125	11.375	11.375	12	10.78	10.375	
8	Lacey & Whitehill									13.25
9	Wm. M. Andrews	12.5			17			12.25	13	
10	J. H. McTighe	15.74	13.49	16.5	14.75	16.5				
11	J. S. McTighe B. C. and I. I. Co	12.49	10.74	11.24	14	12.94	27.5	13.98	12.74	13.5
12	W. L. Withers & Co							10	9.72	
13	H. F. Watkins	11.44	12.7	12.7	12.7	12	15	10	11	16
14	John Burke	9.94	9.94	9.94	9.94	9.94	9.94	9.94	9.94	9.94
15	Wm. Hunt	17.95	17.95	17.95	17.95	17.95	17.95	17.95	17.95	17.95
16	T. Sullivan & Co	9.5	9.5	9.5	8.95	*a* 8.95	*a* 12	*a* 8.95	9	*a* 12
17	J. & A. Wynn	8.9	9.5	10.375	12.75	11	22.5	9	10.5	15
18	W. H. Fitzgerald				*a* 9.2					
19	Thompson & Powell	9.5	9.5	10.5	10.9	10	18	9.9	9.9	
20	Hugh McCarten				12	10		9.98	9.98	15
21	N. I. McLeod	11.98	11.23		10.87	9.43		9.43	9.43	
22	Talley & Outzen	12.2	12	12	14	14	15	11.9	11.9	12
23	Batt O'Brien				12	12		13	12	
24	Hugh Morgan	9.5	*a* 9.5	*a* 9.5	12.24	9.5				
25	M. J. Roach	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7
26	Bryan & King	13.5	12	11.33	10.75	9.5			12	
27	Shippey & Kilpatrick	11.98	11.98	11.98	11.98	11.98	11.98	11.98	11.98	11.98
28	T. Mike	12.49	13	9.99	16.75	9.24	25	9.74	10	13
29	Jas. H. Cary	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
30	McCadden & Co	9.15	9.15	9.15	11.15	9.95	12.95	9.4	9.4	11.15
31	Robt. Johnsen	10.99	12.5	10.99	10.99	9.49	10.99	9.74	*a* 8.74	15.24
32	J. C. McIntyre	12.45	12.45	13.25	12.7	11.9	16.4	13.24	12	
33	P. F. Lamb	15	14.2	14.5	15.25	15.5	16.5	16	15.75	

a Accepted.

List of contracts in force June 30, 1898, in the Lower Yazoo Levee district, with names of contractors, date of approval, of beginning work, and expiration.

Levee stations.	Miles below Cairo.	Contractor.	Date of approval.	Date of beginning work.	Expiration of contract.
300- 400	372 L	Ernest Hyner	Dec. 14, 1896	Feb. 2, 1897	Dec. 1, 1898
500- 600	375 L	E. B. Mantle	do	Dec. 9, 1896	Do.
1037*b*-1200	392 L	Stone & Stansell	Aug. 31, 1897	Sept. 25, 1897	Jan. 1, 1899
60- 100	480 L	L. C. Dulaney	do	Mar. 16, 1898	Do.
100- 150	480 L	T. Mike	do	Apr. 2, 1898	Do.
150- 200	481 L	do	do	Mar. 1, 1898	Do.
6- 100	479 L	C. A. Winter	do	Oct. 22, 1897	June 30, 1898
1018-1034	380 L	McIntyre & Howard	Sept. 10, 1897	Nov. 2, 1897	Apr. 1, 1898
2700-2800	419 L	McCadden & Roach	do	Oct. 12, 1897	Jan. 1, 1899
2800-2880	420 L	Ernest Hyner	do	June 4, 1898	Do.
3000-3100	431 L	do	do	Mar. 8, 1898	Do.
3100-3187	433 L	do	do	Sept. 22, 1897	Dec. 1, 1898
3225*b*-3282	435 L	McLeod & McCarten	do	Nov. 17, 1897	Jan. 1, 1899
3329-3360	436 L	McIntyre & Howard	do	Dec. 9, 1897	Dec. 1, 1898
3360-3400	436 L	P. F. Lamb	do	Sept. 16, 1897	Do.
3400-3440	436 L	McLeod & McCarten	do	Sept. 10, 1897	Do.
3469-3514	436 L	do	do	Aug. 25, 1897	Do.
3880-3930	445 L	Arnold & De Garis	do	Not begun	Jan. 1, 1899
4150-4200	459 L	do	do	do	Do.
4200-4300	460 L	Ben Talley	do	Feb. 24, 1898	Do.
4300-4400	475 L	McCadden & Roach	do	Nov. 12, 1897	Do.
4400-4500	476 L	T. Sullivan	do	Dec. 1, 1897	Do.
900- 993	379 L	J. C. Neely	May 2, 1898	June 6, 1898	Oct. 1, 1898
1037-1058	392 L	Hugh Morgan	do	Not begun	Do.
1202-1235	394 L	do	do	June 6, 1898	Do.
1340-1460	397 L	W. H. Fitzgerald	do	Not begun	Do.
1491-1530	399 L	T. Sullivan & Co	do	do	Do.
1810-1830	402 L	do	do	do	Do.
1870-1980	403 L	do	do	June 3, 1898	Do.
2005-2066	404 L	Robt. Johnsen	do	do	Do.
3166-3186	433 L	T. Sullivan & Co	do	Not begun	Do.

List of contracts in force June 30, 1898, in the Upper Tensas Levee district, with names of contractors, date of approval, of beginning work, and expiration.

Levee stations.	Miles below Cairo.	Contractor.	Date of approval.	Date of beginning work.	Expiration of contract.
Lower Reid Levee.	605 R	L. C. Dulaney	Feb. 4, 1894	Aug. 1, 1894	Dec. 30, 1895
1080–1200	441 R	J. M. Whitehill	Dec. 14, 1896	Feb. 16, 1897	Dec. 1, 1898
0– 256	520 R	Arnold & De Garis	do	Dec. 14, 1896	Mar. 1, 1898
420– 484	427 R	W. M. Bates & Co	Aug. 31, 1897	June 16, 1898	Jan. 1, 1899
630– 660	430 R	J. M. Whitehill	do	June 22, 1898	Do.
780– 800	432 R	do	do	Not begun	Do.
1490–1510	449 R	C. A. Winter	do	do	Do.
1740–1780	452 R	Shippey & Johnsen	do	do	Do.
3160–3185	498 R	W. M. Bates & Co	do	do	Do.
4432–4452	603 R	Ernest Hyner	do	Nov. 10, 1897	Dec. 1, 1898
4452–4472	603 R	do	do	Dec. 16, 1897	Do.
4472–4492	604 R	do	do	Nov. 18, 1897	Do.
4492–4507	604 R	do	do	Oct. 12, 1897	Do.
4540–4551	605 R	Arnold, De Garis & Co.	do	Dec. 7, 1897	Do.
180– 230	425 R	J. M. Whitehill	Sept. 10, 1897	Nov. 23, 1897	Do.
1810–1941	466 R	J. V. Daugherty	do	Oct. 1, 1897	Do.
3065–3100	496 R	W. M. Bates & Co	do	Not begun	Jan. 1, 1899
3328–3428	582 R	J. C. Hodge	do	do	Do.
3428–3550	583 R	T. Sullivan	do	Mar. 23, 1898	Do.
4409–4432	603 R	J. S. McTighe B. C. and I. I. Co	do	Not begun	Dec. 1, 1898
4507–4540	604 R	do	do	do	Jan. 1, 1899
4551–4570	605 R	do	do	do	Do.

List of civilian engineers employed on work of river and harbor improvement in charge of Capt. H. C. Newcomer, Corps of Engineers, from June 30, 1897, to June 30, 1898, inclusive, under the acts approved March 2, 1895, June 3, 1896, March 31, 1897, June 4, 1897, and July 19, 1897.

Name and residence.	Time employed (months).	Compensation per month.	Where employed.	Work on which employed.
Arthur Hider, Greenville, Miss.	12	$250	Greenville, Miss	Care and repairs to plant, construction of towboat, and repairs to revetment works.
E. C. Tollinger, Greenville, Miss.	12	175	do	Construction and repairs of levees in Upper Tensas district in Arkansas.
H. St. L. Coppée, Greenville, Miss.	12	175	do	Construction and repairs of levees in Lower Yazoo district below Greenville.
J. D. Van Meter, Greenville, Miss.	12	150	do	Construction and repairs of levees in Lower Yazoo district above Greenville.
W. S. Brown, Lake Providence, La.	12	150	Lake Providence, La.	Construction and repairs of levees in Upper Tensas district in Louisiana.

APPENDIX 4.

REPORT OF LIEUT. COL. GEORGE McC. DERBY, U. S. VOLUNTEERS, CAPTAIN, CORPS OF ENGINEERS, UPON OPERATIONS IN THE FOURTH DISTRICT.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., June 1, 1898.

COLONEL: I have the honor to submit the following report upon the work of the Fourth district, Mississippi River improvement, for the period from May 1, 1897, to May 1, 1898:

Pursuant to the requirements of Special Orders 110, Adjutant-General's Office, 1897, Additional Second Lieut. George M. Hoffman was relieved from duty under my immediate orders June 10, 1897. Mr. Hoffman's services were highly satisfactory throughout his tour of duty in this district.

The Fourth district, Mississippi River improvement, extends from Warrenton, 7½ miles below Vicksburg, to the Head of the Passes, about 13 miles from the Gulf of Mexico, a distance of 452.8 miles by river.

The works include the improvement of the harbors of Natchez and Vidalia, Mississippi and Louisiana; improvements at the junction of the Mississippi, Red, and Atchafalaya rivers; improvement of the harbor of New Orleans; improvement of the bars in the Mississippi River below Natchez, and the construction, repair, and maintenance of a portion of the levee system of the district.

HARBORS OF NATCHEZ AND VIDALIA.

The project for this work contemplates the construction of a levee on or near the axis of Cowpen Neck, to prevent the flow of water across the neck during high stages of the river, and the construction of about 16,000 linear feet of bank revetment in Giles Bend; estimated cost, $541,300. The object of the proposed work is to prevent the formation of a threatened cut-off at Cowpen Neck, which would cause the destruction of the town of Vidalia, much injury to the water front and landings at Natchez, and increased caving of the banks for many miles above and below, with consequent destruction of expensive parts of the levee system.

The amount expended upon this project to date of last report, May 1, 1897, was $122,722.87, and there remained available a balance of $109,529.17, to which the Mississippi River Commission added on June 4, 1897, a special allotment of $150,000, making the total available for the current fiscal year $259,529.17.

During the current year the enlargement of the levee on Cowpen Neck to a grade of 5 feet above high water of 1890 has been completed, and a specially good season's work has been accomplished in the first efforts toward the protection of Giles Bend.

In accordance with the project submitted March 16, 1897, a copy of which may be found in last year's annual report, the available plant of the district was moved to Giles Bend about July 1, and an organized force was at once put to work cutting willows for the construction of mats and cribs. This work was continued successfully until the end of December, when it was suspended on account of the rising river; 675,000 square feet of mats and 792,000 cubic feet of cribs were constructed and towed from Fairchilds Island to the bank to be protected, a distance of about 8 miles.

The sinking of the spurs was begun during the month of September; the foundation mats for four spurs were sunk in position by October 1.

At this time a most serious difficulty presented itself, which threatened the progress of the work, and but for a speedy adjustment would no doubt have greatly increased its cost. This difficulty arose from the breaking out of yellow fever in the city of New Orleans, causing a panic in the surrounding country.

The city of Natchez and vicinity quarantined against all points, which practically isolated the force at Giles Bend; all means of obtaining provisions were shut off entirely, and telegraphic communication only could be maintained, and that under difficulties. It was finally arranged, however, to station a health officer on the works at the expense of the United States, and the city of Natchez then permitted restricted and conditional intercourse during the months in which the fever prevailed. These circumstances greatly retarded the progress of the work and slightly increased its cost.

In spite of the delays due to quarantine and the late beginning occasioned by the date at which the high water subsided, 15 spurs had been successfully sunk by January 15, when the current of the rising river caused the suspension of the work. The 15 spurs cover about 7,060 feet of bank, which is believed to be the largest season's work ever done in bank protection on the river.

The details of the work accomplished are fully described in the appended report of my assistant, Mr. H. S. Douglas.

I would invite attention particularly to the remarkably low cost of the work, which amounts to only $9.52 per foot of bank protected, the figures being made in the usual way, based upon field expenses only, without allowance for plant and general administration.

It is, of course, quite too early to pronounce upon the success of the work, as the spur-dike system has never been thoroughly tried above Red River, where the conditions differ materially from those that prevail below. As far as known, however, the spurs are still in place, and there has been but little caving between them, while below the length protected the bank has receded this season about 200 feet, as usual. A sketch is herewith, showing the location of the spurs and the rate of caving of the bank.

The intervals between the axis of the spurs are about 450 feet, and experience may prove that this interval is too wide; but even if an extra spur has to be placed in each interval, the first cost of the work will still compare favorably with other revetment work on the river.

In any event, considering the recent gloomy outlook, it is at least encouraging to find once more any promise whatever of success in holding an actively caving bank at moderate expense.

My assistant, Mr. H. S. Douglas, has had immediate charge of this work throughout the year, and has managed it with rare good judgment and energy.

The amount which can be profitably expended during the fiscal year ending June 30, 1900, is $80,000, which will carry the revetment to abreast of the end of the levee on Cowpen Neck and allow a sufficient reserve for the prompt execution of extensive repairs should the spurs be threatened as they were at Greenville.

Thorough and frequent inspection is an essential to the success of this revetment as, for that matter, I believe it to be for any revetment; repairs which can be effected at nominal cost when the necessity first arises, may cost as much as a new revetment if neglected for a few months.

If the Giles Bend revetment fails, it will probably be from one of two causes, the continuance of caving between the spurs, due to eddy action, or the deepening of the channel of the river along a line connecting the outer ends of the spurs. In the first case the spurs may be overthrown laterally or the river may get in between them and shore; in the second case the spurs may be destroyed by being undermined from the outer end inward.

Both of these threatened dangers have their appropriate remedy if the trouble is detected early enough. Eddy action between the spurs can be broken up by placing an additional spur between the original ones, and, in my judgment, such additional spurs should be made with openings through them, to carry out the principle of reducing the velocity of the water in contact with the bank by obstructing the flow, while avoiding obstructing it so much as to reverse the direction of the current.

If the river scours its bed in front of the line of spurs so as to threaten undermining the ends of them, it is evident that the new subaqueous bank so formed must be protected the same as the original bank, by prolonging the spurs until their outer ends rest upon the horizontal bed of the river.

The amount expended from June 30, 1897, to June 30, 1898, is $87,584.87, distributed as follows:

Office expenses (main office)		$3,988.62
Other administrative expenses		14,087.30
Construction of levee (contract)		6,942.51
Construction of revetment (hired labor):		
Materials	$11.309.80	
Wages	31,533.01	
Subsistence	14,330.51	
		57,173.32
Surveys		419.26
Repairs to plant		2,384.20
Care of plant		1,175.76
New plant		1,413.60
Total		87,584.87

Money statement.

IMPROVING HARBORS AT NATCHEZ AND VIDALIA, MISSISSIPPI AND LOUISIANA.

July 1, 1897, balance unexpended		$259,529.17
June 17, 18, 1898, less amount transferred for improving harbor at New Orleans, La		40,000.00
		219,529.17
June 30, 1898, amount expended during fiscal year		87,584.87
July 1, 1898, balance unexpended		131,944.30
July 1, 1898, outstanding liabilities	$186.13	
July 1, 1898, amount covered by uncompleted contracts	2,500.00	
		2,986.13
July 1, 1898, balance available		128,958.17
Amount that can be profitably expended in fiscal year ending June 30, 1900.		80,000.00

JUNCTION OF THE MISSISSIPPI, RED, AND ATCHAFALAYA RIVERS, LOUISIANA.

A detailed description of the difficulties in this vicinity, which the improvements are designed to rectify, will be found in the Annual Report of 1892. In general terms these difficulties consist in the silting up of Old River, the only navigable connection between the Mississippi and the Red and Atchafalaya rivers.

The works heretofore contemplated had in view the following objects:

To check the enlargement of the Atchafalaya and limit its outlet capacity by a system of low relief dams or sills.

To separate the Red from the Atchafalaya during low water and up to a 10-foot stage by means of a low dam at the west end of Turnbull Island, which would deflect the Red around the upper side of the island.

To supply a new outlet for the Red by cutting a canal across Carrs Point and obstructing the lower end of Upper Old River.

The Red would thus always be a tributary of the Mississippi at low stages and the Atchafalaya an outlet, while the conditions at high stages would remain about the same as they were originally.

The plan also contemplated maintaining low-water navigation through Lower Old River, if practicable, by dredging or otherwise, pending the completion of the above system of works.

Owing to insufficient funds, work on all parts of this project except the first and last has been suspended for many years; and experience having demonstrated that the channel in Lower Old River can be kept open with the dredge at moderate expense, even after having been exposed to the effects of extreme high water, it is understood that the improvement of the channel of Upper Old River has been definitely abandoned, narrowing the project to preventing the undue enlargement of the Atchafalaya and the maintenance of a navigable channel through Lower Old River.

During the past year the usual careful examination was made at low-water in the neighborhood of the sill dams near the head of the Atchafalaya. They were found in fair order; some settling had occurred since last examination, and the extensive shoaling of the river reported last year had not proved permanent, the great flood of 1897 having scoured the bed back to substantially the same depths that existed in 1894. It now seems probable that the sill dams will require extensive repairs at an early date.

The gauge at Red River Landing reading 8.65 on August 31, with a falling river, the dredge *Ram* was sent to Old River, where she began dredging at once. It is estimated that 51,940 cubic yards of material were dredged and deposited in the stream alongside the cut made by the dredge.

The gauge at Red River Landing fell to zero during the season, and the channel was dredged for a navigable depth of 5¼ feet at extreme low water. Navigation was maintained throughout the low-water season without interruption. This result cost $2,167.45, as compared with $2,320.40 last year, $8,333.19 for 1896, and $19,304.29 for 1895. No dredging was required after October 31.

For further details of the work accomplished during the year reference is made to the report of Mr. A. F. Woolley, assistant engineer, herewith.

No new appropriation for the fiscal year ending June 30, 1900, will be necessary, as the balance available, about $69.000, is sufficient to cover the expense of repairing the sill dams and dredging in Lower Old River, including the cost of a new steel hull, which will be needed for the dredge *Ram* this season.

The amount expended from June 30, 1897, to June 30, 1898, is $15,623.45, distributed as follows:

Office expenses (main office)		$3,830.01
Other administrative expenses		1,598.29
Dredging Old River:		
Materials	$481.92	
Wages	2,514.80	
Subsistence	533.28	
		3,530.00
Surveys		14.00
Repairs to plant		3,511.33
Care of plant		2,742.37
New plant		397.45
Total		15,623.45

Money statement.

IMPROVING ATCHAFALAYA AND RED RIVERS, LOUISIANA.

July 1, 1897, balance unexpended		$82,961.32
June 30, 1898, amount expended during fiscal year		15,623.45
July 1, 1898, balance unexpended		67,337.87
July 1, 1898, outstanding liabilities	$100.58	
July 1, 1898, amount covered by uncompleted contracts	2,500.00	
		2,600.58
July 1, 1898, balance available		64,737.29

NEW ORLEANS HARBOR.

During the past season all of the available plant of the district has been in u
at Giles Bend, and nothing therefore has been done at New Orleans Harbor. Ope
ations have been confined to making necessary repairs to the floating plant at t
Government depot.

During the month of November, 1897, serious caving occurred at Algiers Point a
in the Third district reach, immediately below the last spur of the system.

The cave at Algiers Point was quite large and destroyed a great deal of valuab
property. A survey of the locality had been previously made, pursuant to instru
tions from the president of the Mississippi River Commission, and on November
the following project was submitted for the protection of the point:

"Prior to the date of the survey the bank had caved above and below the fer
landing, carrying away the landing and the greater part of the ferry house. Sin
the completion of the survey there has been another large cave a short distance abo
the ferry; the Grand Isle depot was destroyed, and the levee carried into the riv
for a distance of about 400 feet. This cave has not yet reached a settled conditio
and the bank is still slowly crumbling away at the top.

"The break in the levee will necessitate the construction of a new line some di
tance to the rear, which will be expensive to build and will throw outside the lev
line property valued at about $100,000, consisting principally of small stores an
residences.

"The upper side of Algiers Point has been known as a caving bank for years.
does not wear away perceptibly, little by little, but at intervals of years caves aw
in large masses, destroying an acre or two of land at a time.

"The water offshore is generally over 100 feet deep. At low water there is litt
or no current, as the enormous cross section of the river gives it a carrying capaci
far in excess of low-water requirements. On the other hand, during high water t
carrying capacity of the river at this point is taxed to the utmost.

"A comparison of the soundings taken in 1894 with those recently taken sho
that much erosion has taken place in deep water; the banks have uniformly increas
in steepness, so that for long distances above the point where no caving has tak
place for many years it is now imminent. There are, in fact, many places where t
bank is now much steeper than it was at the points where it has already caved th
season.

"To put a mattress revetment on a bank of this character in its present conditi
would merely be to invite its destruction; for, while it would doubtless preve
further erosion of the bank, it would add nothing to its stability, which is alrea
impaired.

"If a system of spur dikes at ordinary intervals were used, experience would in
cate that the points propped up by the spurs would stand for a long time, but th
the rest of the bank would cave even to the extent of stripping the foundation m
from around the spur proper, and thereby ultimately compassing the destruction
the spur itself.

"On the other hand, it seems to me probable that before this work can be unde
taken the steepest portions of the bank will have caved off and the slopes to
protected will have become more moderate.

"The people of Algiers are naturally very anxious to see the work begun at onc
but any work done now would be extraordinarily expensive, and it would hardly
practicable to accomplish enough to be of any use. All of the plant of the distri
is now actively at work at Giles Bend, and even if plant could be borrowed fro
the Third district we could hardly get organized and at work before special diffic
ties would have to be met by reason of the drift brought down by the rising rive
and these difficulties have never been overcome heretofore except at great expen
and risk. Finally, no considerable amount of work could be done, even if the ri
and expense were justifiable, before operations would necessarily be interrupted
the flooding of the low willow bars, where the materials for construction
obtained.

"I assume, therefore, that this work will not be undertaken until next season, a
would recommend that a system of 11 spur-dikes be constructed with intervals
about 450 feet, beginning at the lower Gouldsboro spur, known as No. 6, and exten
ing to below the ferry landing at Algiers, as shown on the accompanying drawing.

"The foundation mats should be 400 feet by 150 feet, and the spurs should be bu
to a slope of 1 in 3 from low-water mark and not less than two cribs high.

"The length of bank to be protected is about 5,000 feet and the field cost of t
work would be about $15 a foot. To provide for buttressing the portions of t
bank between spurs, where the slope of the bank greatly exceeds 1 in 2½, two spec
buttresses built of two cribs without foundation mats will be placed in each su
interval, the lower crib to be the longer and not less than 28 feet wide. As the co
formation of the bank will probably undergo considerable changes between n
and the time of doing the work, the special buttresses are not shown on the ma

but I would estimate their field cost at about $7 per running foot of bank, which would make the total estimate for the work as follows:

Estimate.

5,000 feet of spur dike bank protection, at $15	$75,000
5,000 feet of additional buttressing, at $7	35,000
Administration and contingencies (10 per cent)	11,000
Total	121,000

I have now on hand a balance of $51,500 from the last appropriation for New Orleans Harbor, of which about $1,500 will be needed for repairs to the lower spur in the Third district series, which is threatened by a recent cave immediately below it. If no other serious caving occurs this season on the New Orleans side, the remainder of the above balance would be available for Algiers Point, and I would recommend its application to the execution of the above project, with such additional funds as the Commission may be able to allot.

The urgency of the work in New Orleans Harbor has long been known, and an appropriation of $300,000 has been asked for annually for many years, but only about one-sixth of the amount has been appropriated on the average.”

The above project was approved March 1, 1898, and it is expected that work will be begun as soon as practicable after the present high water has subsided, working from the lower end upward as far as the available funds will permit.

For further details connected with the work of repairs and inspection, reference is made to the accompanying report of Mr. H. S. Douglas, assistant engineer.

To secure economy in the management of the improvement of New Orleans Harbor, appropriations of not less than $200,000 per annum are necessary. In this connection it is to be observed that floating plant, consisting of wooden barges and steamboats, deteriorates very rapidly in this climate, and this action goes on just as rapidly when the plant is idle as when it is at work. There are other heavy expenses, for watchmen and superintendence, that can not be avoided when the plant is idle, so that the cost of the work done in New Orleans is greatly increased by the irregularity and inadequacy of the appropriations.

The amount that can be profitably expended during the fiscal year ending June 30, 1900, is $300,000. If this amount can not be appropriated at once, an important saving in the cost of the work could still be secured by placing it under the continuing contract system, which would enable the engineer in charge to look ahead and carry on the work systematically. This can hardly be done when large appropriations are made some years, and there is no certainty whatever whether there will be any at all for the next year.

The amount expended from June 30, 1897, to June 30, 1898, is $6,655.44, distributed as follows:

Office expenses (main office)	$1,130.39
Other administrative expenses	1,587.88
Construction, materials	1,128.74
Repairs to plant	1,610.59
Care of plant	319.99
New plant	877.85
Total	6,655.44

Money statement.

IMPROVING HARBOR AT NEW ORLEANS, LA.

July 1, 1897, balance unexpended		$57,907.30
June 18, 1898, amount transferred from appropriation for Lake Providence Reach		10,000.00
June 18, 1898, amount transferred from appropriation for prevention of cut-off at Giles Bend, Miss		40,000.00
		107,907.30
June 30, 1898, amount expended during fiscal year		6,655.44
July 1, 1898, balance unexpended		101,251.86
July 1, 1898, outstanding liabilities	$240.20	
July 1, 1898, amount covered by uncompleted contracts	10,475.00	
		10,715.20
July 1, 1898, balance available		90,536.66
Amount that can be profitably expended in fiscal year ending June 30, 1900		300,000.00

DREDGING BARS BELOW NATCHEZ.

The bars in the Mississippi River, at Natchez Island, Ford's, Torras, and Tuni caused some difficulty to navigation during low water this season.

In compliance with telegraphic instructions from the president of the Mississi River Commission, the dredge *Ram* was sent to Ford's Crossing on November 27. was stationed there for fifteen days to buoy the channel and assist steamboats o the bars below Natchez, should the necessity arise; but no assistance was requir and no dredging became necessary. The river having risen sufficiently, the *R* was withdrawn on December 12 and returned to New Orleans.

The exact condition of these bars is not well known; the river is very wide a the channel not well marked, so that it is doubtful whether vessels go aground account of an actual lack of water, or because they happen to be out of the chann

It is believed that much of the difficulty that has been experienced heretofore be obviated by stationing the small steamboat *Ruby* at these bars early in the se son, to keep track of the shifting channel and keep it thoroughly buoyed.

The amount expended from June 30, 1897, to June 30, 1898, is $542.18, distribut as follows:

Administrative expenses		$44.
Dredge:		
Materials	$120.00	
Wages	285.00	
Subsistence	90.18	
		495.
Care of plant		3.
Total		542.

Money statement.

DREDGES AND DREDGING.

Amount allotted	$542
June 30, 1898, amount expended during fiscal year	542

PLANT.

All of the plant of the district is in excellent condition, better than at any ti since I have been in charge.

The hull of the towboat *Osceola* having decayed beyond the point of economi repair, she was condemned during the year, and a contract has been made for construction of a steel towboat with compound engines, to be completed and del ered during the coming season.

In order to maintain the plant in a proper state of efficiency, it will be necess to purchase shortly four or more new barges.

Work is now in progress on plans for these barges, which experience has sho should be built entirely of steel, or at least have steel frames.

The report of Mr. H. S. Douglas, on repairs to plant, is herewith appended.

The amount expended from June 30, 1897, to June 30, 1898, is $11,808.12, distribu as follows:

Office expenses (main office)		$172
Other administrative expenses		1,570
New plant		2,379
Repairs (hired labor):		
Materials	$3,469.53	
Wages	4,009.57	
		7,479
Care of plant		206
Total		11,808

Money statement.

PLANT.

July 1, 1897, balance unexpended	$10,000
Amount allotted, act of June 4, 1897	20,000
	30,000
June 30, 1898, amount expended during fiscal year	11,808
July 1, 1898, balance unexpended	18,191

July 1, 1898, outstanding liabilities	$483.54	
July 1, 1898, amount covered by contract	7,656.54	
		$8,140.08
July 1, 1898, balance available		10,051.80

SURVEYS, GAUGES, AND OBSERVATIONS.

The survey of Algiers Point and the survey of the sill dams in the Atchafalaya River, both of which have been reported elsewhere, constitute the only work of this character done during the past year.

The gauge at Barbres Landing, at the junction of the Red and Atchafalaya rivers, has been maintained as heretofore.

The amount expended from June 30, 1897, to June 30, 1898, is $680.71, distributed as follows:

Office expenses (main office)		$10.06
Other administrative expenses		153.08
Field work and drafting:		
Materials	$0.50	
Wages	376.40	
Subsistence	87.81	
		464.71
Repairs to plant		7.18
Care of plant		.94
New plant		44.80
Total		680.71

Money statement.

SURVEYS, GAUGES, AND OBSERVATIONS.

July 1, 1897, balance unexpended	$3,140.33
August 25, 1897, amount allotted for survey of Algiers Point	500.00
	3,640.33
June 30, 1898, amount expended during fiscal year	680.71
July 1, 1898, balance unexpended	2,959.62
July 1, 1898, balance available	2,959.62

LEVEES.

For work connected with levee construction and maintenance, the district is subdivided into several levee districts, as follows:

The Lower Tensas Levee district, right bank, which extends from the upper limits of the Fourth district, opposite Warrenton, to the mouth of Red River. In this district the levee system is continuous from the upper end to a point 5 miles below Fairview Landing, 131.5 miles by river, leaving about 26 miles unprotected.

The Atchafalaya Levee district, right bank, which extends from the mouth of Red River to the head of Bayou Lafourche, a distance of 122 miles by river. The levee system is continuous in this district.

The Lafourche Levee district, right bank, which extends from the head of Bayou Lafourche to New Orleans. The distance by river is 78 miles, and the levee system is continuous.

The Barataria Levee district, right bank, which extends from New Orleans to the Head of the Passes, 82¼ miles. The levee system is continuous down to the Jump, 71.5 miles.

The Homochitto Levee district, left bank, created by a resolution of the Mississippi River Commission November 19, 1894, which extends from the mouth of the Yazoo River to Baton Rouge, 238.5 miles by river. There are as yet no levees in this district, except a few detached lengths built by private parties.

The Pontchartrain Levee district, left bank, which extends from Baton Rouge to New Orleans, 123.5 miles. The levees are continuous.

The Lake Borgne Levee district, left bank, which extends from New Orleans to the Head of the Passes, 91 miles. The levee system at present only extends to Fort St. Philip, covering 70 miles of the river.

Attention is invited to the accompanying report of Mr. W. J. Hardee, assistant engineer.

The funds available for levee construction in this district May 1, 1897, amou
to $101,584.91. This amount was subsequently increased to $777,734.91 by the a
ments made from the appropriations of June 4 and July 19, 1897.

The contracts for levee construction awarded during the year covered by
report amount to 3,392,206 cubic yards, at an average price of 14.12 cents, as comp
with 1,774,830 cubic yards, at 10.99 cents for the preceding year. The marked inc
in cost is due in part to the fact that the contracts made happened to be in loca
where the work is always more expensive than the average, but mainly to the
date at which the funds became available.

COST OF LEVEE BUILDING.

The construction and maintenance of an effective levee system is an underta
of such vast magnitude that it is only financially practicable on condition of
economy in the expenditure of the available funds. The following table shows
the cost of levee building has varied in my district during recent years:

Year.	Quantity.	C per y
	Cubicyards.	*Ce*
1890	895,000	
1891	1,410,000	
1892	908,000	
1893	2,142,000	
1894	3,589,000	
1895	3,414,000	
1896	4,658,000	
1897	1,775,000	
1898	3,392,200	

It will be observed that the average price paid in 1896 was less than one-half
paid in 1893, making it possible to do more than twice the amount of work wit
same amount of money. On the other hand, since 1896 there has been a ma
increase in the price paid; so that for the current fiscal year the cost of the
exceeds by about 40 per cent the cost of the same work in 1896.

While there are other factors which to a certain extent affect the question o
average annual price of levee work, there is no doubt whatever that the policy
sued this year in making contracts is largely responsible for the great increa
the cost of the work which has recently taken place.

We have this year been compelled to conduct our business on the extrava
principle of obstructing our own work and cornering our own market, and
investing heavily at the high prices we had ourselves created.

The allotments for levee construction below Cairo for the past fiscal year amou
to $1,674,200, which, at 10.3 cents per cubic yard, would correspond to about 16,00
cubic yards of earthwork. This, in connection with the similar amount of
done by the local levee boards, is an enormous year's work, which, for econo
results, would tax to the utmost the working capacity of all the contractors o
river for the whole twelve months of the year.

But instead of our allowing them twelve months to do the work this year, the
appropriations did not become available until fall, and the extremely val
months of June, July, August, and September were entirely lost.

In order to be ready for the succeeding high water the date of completio
contracts had to be set at March 1, so that practically contractors had onl
months' time in which to accomplish a very large year's work, and these five mo
those when the days are the shortest and the work most likely to be interrupte
wet weather, which converts the dry, easily-handled earth into heavy impassable

It is manifest that economical work can not be done under the above condit
a premium must be paid contractors for the extra difficulties we compel them to
and the extra speed we exact of them. But in addition to the above obstructio
economical work, it is patent to any business man what must be the result of
denly throwing upon the market at one time a volume of work far in excess of
all of the available forces on the river can possibly accomplish. Competition is
lutely killed and contractors, big and little, are placed in a position to demand
price they choose.

It was under the above conditions that last season's work was put under cont
and the result is well shown by the price paid.

These difficulties could largely be obviated by authorizing the district offic
make contracts, as was formerly the practice, in advance of appropriations, pay
to be made when Congress shall have appropriated the funds. In this way a

amount of money can be saved, a great deal more work can be done during the year, and much of it can be done in time to be well compacted and sodded before it will have to be exposed to a flood.

HIGH WATER.

The river has been out of its banks twice this season; it rose rapidly to 43.1 feet at Vicksburg in February, then fell to 19.5 feet in March, and again rose to 49.4 feet in April. With one exception this is the highest gauge-reading record at Vicksburg, and it is the highest ever carried to the Gulf without a crevasse in the levee line. As Red River remained extraordinarily low throughout the season, the high water of 1898 was excessive in the Lower Tensas district only; in this district the system of depots at intervals of 5 miles along the levee line had been established and equipped with emergency outfits of skiffs, tools, lumber, etc.; competent inspectors were placed in charge of them as soon as the flood reached serious proportions. The following is the letter of instructions given these inspectors:

"You are hereby assigned to high-water duty, as inspector, on 15 miles of the levee line of the Lower Tensas Levee district, embracing the three sections pertaining to Depots Nos. —, —, and —. You will reside at or near Depot No. —.

"1. *Depots.*—At each of these depots there will be a man employed by this office who will be under your orders; he will have charge of emergency supplies belonging to the United States and furnished for the use of the local levee authorities for the protection of the levee line during high water.

"It shall be the duty of these men, who will at all times remain at their depots, to issue tools and materials on the order of the levee commissioner or his agent, taking receipt for the articles delivered.

"2. *Inspection.*—It will be your duty to carefully inspect every foot of the 15 miles of your line daily.

"3. *Weeds.*—Wherever the back of the levee is so overgrown as to interfere with easy and thorough inspection, the weeds and grass should be cut at once.

"4. *Drainage.*—Wherever the back of the levee becomes wet, drainage should at once be provided by means of narrow V-shaped gullies, a few inches deep, on the back of the levee, to carry the water off the slope quickly, so that the levee may not become saturated; a shallow seepage ditch should be dug, about 2 feet clear of the base of the levee, to receive the water from the slopes, which should then be conducted as frequently as possible to some line of natural drainage in rear of the levee.

"5. *Watchmen.*—Whenever the water in the river gets to within 3 feet of the crown of the levee there should be a day watchman and a night watchman for every 2½ miles of levee line.

"Whenever at any point the back of the levee shows leaks or signs of sloughing, even if the river has not reached the height of 3 feet below the crown of the levee, the day and night watchmen should be put on duty; if the conditions become specially dangerous, the length of the beat of these watchmen should be reduced accordingly, even in some cases to such a degree as to enable the watchman to cover every foot of his beat at least once in every half hour. All watchmen are to be employed and paid by the local authorities, and it will be your duty to report to the levee commissioner, or his agent, when and where you think they are necessary.

"6. *Wave wash.*—Where the levee is being injured by wave wash, the inspector will make a careful examination of the extent of the probable injury, and if there is any risk of the safety of the levee being impaired, a temporary revetment should be constructed.

"In the general case it is cheaper to replace wave wash after the river has fallen than to undertake to prevent it with revetments.

"7. *Relations with local authorities.*—The inspector will take the first opportunity to meet the local levee commissioner and will cultivate harmonious and cordial relations with the people of the district, familiarizing himself with the resources of the locality.

"He will inform the local levee commissioner, or his agent, reporting the fact to this office, whenever in his judgment it becomes necessary to take any of the precautions indicated above. The question as to whether the work shall actually be done will rest of course entirely with the local authorities, on whom the expense must necessarily fall.

"8. *Reports.*—You will submit a report at the end of every week, stating the general condition of the levee line on your beat; also anything of particular interest which may have occurred."

The system outlined above worked well, and it will be extended to the other levee districts during the coming year.

The great improvements that have been made in the levee line during recent years have a tendency to develop a dangerous overconfidence in the minds of all concerned. Constant effort will be necessary to keep in mind the fact that a levee line is like a fortification, a good line of defense to fight behind, but, like all other fortifications, however strong, it must be actively defended or its apparent strength will c the magnitude of the ultimate disaster.

When a levee has 6 feet of water against it there is always sufficient da to justify and demand a daily inspection. This is an important principl not yet won general recognition on the Mississippi.

No work has been done in the Homochitto Levee district, there hav funds available.

The details of the work accomplished during the year in the other given in the following tables:

Fourth district levees, 1897–98.

LOWER TENSAS LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.
					Feet.
	Evergreen:				
1	Section 3	637	R	Batt O'Brien	1,300
2	Section 4	637	R	do	1,300
3	Section 5	637	R	do	1,100
4	Section 8	637	R	do	1,147
	Winter quarters:				
5	Section 1	640	R	Charles O'Donnell	2,853
6	Section 2	640	R	do	2,800
7	Bondurant, section 3.	642	R	Jas. G. Boney	7,670
8	Cottage Home, section 1.	650	R	C. D. Leeper	3,970
9	Harpers, section 2.	651	R	Garbish & O'Neil	11,517
10	L'Argent	665	R	John Scott & Sons	8,314
	L'Argent to Gibsons:				
11	Section 1	680	R	Garbish & O'Neil	870
12	Section 2	680	R	do	700
13	Section 3	680	R	do	800
14	Section 4	680	R	do	1,000
15	Section 5	680	R	do	900
16	Section 6	680	R	do	800
17	Section 7	680	R	T. A. Helgason	900
18	Section 8	680	R	do	800
19	Section 9	680	R	do	700
20	Section 10	680	R	do	700
21	Section 11	680	R	do	700
22	Section 12	680	R	do	800
	Delhi:				
23	Section 1	680	R	Helgason Bros	800
24	Section 2	680	R	do	852
25	Section 3	680	R	do	748
26	Section 12	680	R	do	900
27	Rifle Point, section 3.	689	R	Manning & Gibson	4,200
28	Morville	710	R	James R. Marlow	4,952
29	Morville to Greens.	712	R	do	4,651
	Esperanza:				
30	Section 5	715	R	C. E. Ponder	900
31	Section 7	715	R	Batt O'Brien	800
32	Section 8	715	R	do	700
33	Section 9	715	R	do	800
34	Section 11	715	R	Charles O'Donnell	800
35	Section 12	715	R	do	900
36	Section 14	715	R	do	1,000
37	Section 19	715	R	James R. Marlow	433
38	Section 20	715	R	do	767
39	Section 21	715	R	do	1,200
40	Section 22	715	R	do	1,200
41	Section 23	715	R	do	1,300
42	Section 24	715	R	do	1,300
	Ashley to Fairview:				
43	Section 1	725	R	D. P. Lyles	2,985
44	Section 7	725	R	do	3,000
45	Section 8	725	R	do	3,261
46	Fairview	725	R	do	1,052
47	Glasscock	728	R	C. L. Blake	1,526

Fourth district levees, 1897-98—Continued.

LOWER TENSAS LEVEE DISTRICT—Continued.

No.	Name of levee.	Section.			New or enlargement.	Average height.		Date of contract.	Work completed.
		Crown	Land slope.	River slope.		Above old levee.	Ground surface.		
	Evergreen:	*Feet.*				*Feet.*	*Feet.*	1896.	1897.
1	Section 3	8	3 to 1	3 to 1	Enlargement	4.3	11.1	Oct. 15	Oct. 25
2	Section 4	8	3 to 1	3 to 1	do	4.4	11.1	do	Do.
3	Section 5	8	3 to 1	3 to 1	do	4.3	11.1	do	Nov. 4
4	Section 8	8	3 to 1	3 to 1	do	4.1	11.1	do	Dec. 7
	Winter quarters:								
5	Section 1	8	3 to 1	3 to 1	do	3.9	12.3	Sept. 5	Nov. 18
6	Section 2	8	3 to 1	3 to 1	do	4.1	13.1	do	Dec. 20
7	Bondurant, section 3.	8	3 to 1	3 to 1	do	2.6	9.7	Oct. 15	Dec. 21
8	Cottage Home, section 1.	8	3 to 1	3 to 1	do	2.7	11.4	Sept. 5	Sept. 8
9	Harpers, section 2.	8	3 to 1	3 to 1	do	2.2	11.7	do	Sept. 28
10	L'Argent	8	3 to 1	3 to 1	New	4.2	18.9	1897. Sept. 27	1898. Part.
	L'Argent to Gibsons:								
11	Section 1	8	3 to 1	3 to 1	Enlargement	3.6	18.8	Sept. 1	Feb. 11
12	Section 2	8	3 to 1	3 to 1	do	3.8	18	do	1897. Dec. 28
13	Section 3	8	3 to 1	3 to 1	do	3.9	18	do	Nov. 17
14	Section 4	8	3 to 1	3 to 1	do	3.9	14.8	do	Oct. 20
15	Section 5	8	3 to 1	3 to 1	do	4.9	16	do	1898. Jan. 18
16	Section 6	8	3 to 1	3 to 1	do	3.9	16.5	do	1897. Nov. 30
17	Section 7	8	3 to 1	3 to 1	do	3.8	17.7	do	Nov. 26
18	Section 8	8	3 to 1	3 to 1	do	4.3	17.7	do	Oct. 20
19	Section 9	8	3 to 1	3 to 1	do	4.7	17.7	do	Nov. 30
20	Section 10	8	3 to 1	3 to 1	do	4.6	17.7	do	Dec. 29
21	Section 11	8	3 to 1	3 to 1	do	4.5	17;7	do	1898. Feb. 11
22	Section 12	8	3 to 1	3 to 1	do	4.9	17.7	do	Feb. 15
	Delhi:								
23	Section 1	8	3 to 1	3 to 1	do	4.4	16.2	Sept. 27	Apr. 4
24	Section 2	8	3 to 1	3 to 1	do	3.8	16.2	do	Apr. 25
25	Section 3	8	3 to 1	3 to 1	do	4	16.2	do	Do.
26	Section 12	8	3 to 1	3 to 1	do	4.5	16.2	do	Do.
27	Rifle Point, section 3.	8	3 to 1	3 to 1	do	3.5	9.1	1896. Oct. 15	Mar. 11
28	Morville	8	3 to 1	3 to 1	do	2.7	7.1	Sept. 5	1897. Dec. 13
29	Morville to Greens.	8	3 to 1	3 to 1	do	2.9	9.1	do	Dec. 20
	Esperanza:							1897.	1898.
30	Section 5	8	3 to 1	3 to 1	do	5	18.9	Dec. 10	Apr. 1
31	Section 7	8	3 to 1	3 to 1	do	4.9	20.3	do	Feb. 28
32	Section 8	8	3 to 1	3 to 1	do	4.7	20.3	do	Feb. 5
33	Section 9	8	3 to 1	3 to 1	do	4.9	20.3	do	Apr. 4
34	Section 11	8	3 to 1	3 to 1	do	4.7	15.7	Sept. 27	Jan. 17
35	Section 12	8	3 to 1	3 to 1	do	4.9	15.7	do	Apr. 11
36	Section 14	8	3 to 1	3 to 1	do	4.3	15.7	do	Do.
37	Section 19	8	3 to 1	3 to 1	do	4.4	15.7	Nov. 24	Apr. 19
38	Section 20	8	3 to 1	3 to 1	do	4.7	15.7	Oct. 20	Mar. 18
39	Section 21	8	3 to 1	3 to 1	do	4.6	15.7	do	Feb. 10
40	Section 22	8	3 to 1	3 to 1	do	4.9	15.7	do	Apr. 13
41	Section 23	8	3 to 1	3 to 1	do	5	15.7	do	Mar. 18
42	Section 24	8	3 to 1	3 to 1	do	3.9	15.7	do	Jan. 24
	Ashley to Fairview:							1896.	1897.
43	Section 1	8	3 to 1	3 to 1	do	1.9	12.8	Oct. 26	Part.
44	Section 7	8	3 to 1	3 to 1	do	2.5	13.9	do	Dec. 21
45	Section 8	8	3 to 1	3 to 1	do	2.4	13.9	do	Do.
46	Fairview	8	3 to 1	3 to 1	New	2	7.4	1897. Sept. 27	1898. Feb. 12
47	Glasscock	8	3 to 1	3 to 1	do	2.5	15.8	Oct. 20	Apr. 13

Fourth district levees, 1897-98—Continued.

LOWER TENSAS LEVEE DISTRICT—Continued.

No.	Name of levee.	Total yardage paid for.	Price per cubic yard.	Total cost.	Distance from center of levee to river bank.			Nature of r bank.
					Least.	Greatest.	Average.	
	Evergreen:	*Cu. yds.*	*Cents.*		*Feet.*	*Feet.*	*Feet.*	
1	Section 3	15, 648. 13	9. 43	$1, 475. 62	10, 017	11, 560	10, 820	Making.
2	Section 4	16, 364. 39	9. 43	1, 543. 17	9, 740	10, 017	9, 895	Do.
3	Section 5	16, 039. 90	9. 43	1, 512. 56	8, 994	9, 740	9, 600	Do.
4	Section 8	16, 810. 72	9. 43	1, 585. 25	7, 241	8, 500	7, 850	Do.
	Winter quarters:							
5	Section 1	39, 087. 13	14. 50	5, 667. 64	3, 850	5, 905	4, 750	Do.
6	Section 2	39, 456. 29	15. 50	6, 115. 72	1, 790	3, 850	2, 750	Do.
7	**Bondurant, section 3**	48, 106. 08	8. 50	4, 089. 02	448	1, 290	778	Caving.
8	**Cottage Home, section 1**	36, 111. 82	10. 49	3, 788. 13	1, 020	1, 390	1, 178	Do.
9	**Harpers, section 2**	78, 551. 14	14	10, 997. 16	690	1, 840	1, 230	Washing caving.
10	**L'Argent**	90, 626. 40	14. 40	13, 050. 21	2, 725	4, 215	3, 415	Caving.
	L'Argent to Gibsons:							
11	Section 1	15, 285. 67	12. 45	1, 903. 06	365	630	490	Stationary.
12	Section 2	14, 795. 21	13. 50	1, 997. 35	630	896	725	Do.
13	Section 3	12, 482. 50	12. 45	1, 554. 07	740	1, 015	861	Do.
14	Section 4	15, 577. 19	12. 45	1, 939. 36	571	740	654	Do.
15	Section 5	15, 402. 38	12. 45	1, 917. 59	545	571	628	Do.
16	Section 6	14, 211. 28	12. 45	1, 769. 31	534	545	540	Do.
17	Section 7	15, 205. 73	13. 95	2, 121. 20	465	581	519	Do.
18	Section 8	13, 947. 90	13. 95	1, 945. 73	385	465	410	Do.
19	Section 9	14, 556. 18	13. 95	2, 030. 59	358	405	378	Do.
20	Section 10	15, 665. 66	13. 95	2, 185. 36	335	464	391	Do.
21	Section 11	17, 198. 54	13. 95	2, 399. 20	464	485	474	Do.
22	Section 12	16, 609. 48	13. 95	2, 317. 02	485	543	517	Do.
	Delhi:							
23	Section 1	15, 496. 72	13	2, 014. 57	410	560	475	Caving.
24	Section 2	16, 655. 09	13	2, 165. 16	235	410	340	Do.
25	Section 3	15, 589. 57	13	2, 026. 64	425	890	700	Do.
26	Section 12	14, 664. 28	13	1, 906. 36	1, 460	1, 700	1, 584	Do.
27	**Rifle Point, section 3**	35, 864. 10	9	3, 227. 77	6, 350	9, 700	7, 840	Making
28	**Morville**	28, 335. 76	8. 50	2, 408. 54	1, 050	1, 710	1, 360	Stationary
29	**Morville to Greens**	25, 758. 05	9. 90	2, 550. 05	1, 000	1, 750	1, 380	Making.
	Esperanza:							
30	Section 5	16, 111. 61	19. 50	3, 141. 76	910	1, 240	1, 115	Stationary
31	Section 7	15, 038. 88	19. 90	2, 992. 73	615	910	795	Do.
32	Section 8	14, 284. 60	19. 90	2, 842. 63	910	1, 290	1, 065	Do.
33	Section 9	15, 061. 36	19. 90	2, 997. 21	526	1, 290	800	Do.
34	Section 11	13, 743. 05	19	2, 611. 18	526	705	610	Do.
35	Section 12	14, 685. 54	19	2, 790. 26	710	850	790	Do.
36	Section 14	14, 730. 90	19	2, 798. 88	810	810	774	Do.
37	Section 19	5, 494. 06	17. 50	961. 46	5, 700	14, 000	9, 800	Making.
38	Section 20	9, 265. 71	13. 70	1, 269. 40	2, 600	5, 700	4, 720	Do.
39	Section 21	15, 082. 55	13. 70	2, 066. 31	1, 450	2, 600	2, 050	Do.
40	Section 22	16, 608. 32	13. 70	2, 275. 34	1, 205	1, 450	1, 380	Do.
41	Section 23	16, 706. 35	13. 70	2, 288. 84	712	1, 205	960	Do.
42	Section 24	16, 321. 40	13. 70	2, 236. 03	712	862	785	Stationary
	Ashley to Fairview:							
43	Section 1	15, 000. 00	10	1, 500. 00	1, 000	1, 310	1, 175	Do.
44	Section 7	18, 006. 44	10	1, 800. 64	800	1, 990	1, 330	Caving.
45	Section 8	14, 384. 46	9. 24	1, 329. 12	1, 900	1, 350	1, 560	Do.
46	**Fairview**	8, 718. 29	10. 24	892. 75	803	950	880	Do.
47	**Glasscock**	44, 909. 82	20	8, 981. 97	1, 850	2, 280	2, 025	Do.

Fourth district levees, 1897–98—Continued.

ATCHAFALAYA LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
					Feet.	*Feet.*	*Feet.*
1	Raccourci	785	R.	E. P. White	3,700	3,000	3
2	Raccourci to Longwood, section 9	785	R.	.....do	1,823	2,000	2.5
3	Fleta, section 1	786	R.	.....do	985	575	5.7
	Morrison:						
4	Section 5	793	R.	Geo. Y. Andrews	988	980	5.7
5	Section 6	793	R.	.....do	1,100	950	5.7
6	Section 8	793	R.	.....do	1,100	900	5.7
	Point Coupee:						
7	Section 1	796	R.	.....do	941	940	5.3
8	Section 3	796	R.	.....do	867	700	5.3
	St. Francis Church:						
9	Section 1	799	R.	Whipple & Gammill	890	900	5.3
10	Section 2	799	R.	.....do	1,000	1,000	5.3
11	Section 3	799	R.	.....do	1,100	1,100	5.3
12	Section 4	799	R.	.....do	900	800	5.3
13	Section 5	799	R.	.....do	1,100	1,100	5.3
14	Section 6	799	R.	.....do	1,286	1,290	5.3
15	St. Claude	806	R.	F. M. McLaughlin	2,210	2,200	5.4

No.	Name of levee.	Section.			New or enlargement.	Average height.		Date of contract.	Work completed.
		Crown.	Land slope.	River slope.		Above old levee.	Ground surface.		
		Feet.				*Feet.*	*Feet.*		
1	Raccourci	8	2½ to 1	3 to 1	Enlargement.	2.2	14.9	1896. May 4	1897. Sept. 4
2	Raccourci to Longwood, section 9.	8	2½ to 1	3 to 1	....do ...	1.6	16.3	....do ...	1898. Apr. 15
3	Fleta, section 1	8	3 to 1	3 to 1	....do ...	3.9	20.3	1897. Sept. 11	Apr. 19
	Morrison:								
4	Section 5	8	3 to 1	3 to 1	....do ...	3.3	16	....do ...	1897. Dec. 3
5	Section 6	8	3 to 1	3 to 1	....do ...	3.1	16.7	....do ...	Dec. 28
6	Section 8	8	3 to 1	3 to 1	....do ...	3.6	18.6	....do ...	1898. Feb. 1
	Point Coupee:								
7	Section 1	8	3 to 1	3 to 1	....do ...	3.5	17.4	....do ...	Do.
8	Section 3	8	3 to 1	3 to 1	....do ...	3.2	17.2	....do ...	Apr. 15
	St. Francis Church:								
9	Section 1	8	3 to 1	3 to 1	....do ...	2.6	20	....do ...	Feb. 15
10	Section 2	8	3 to 1	3 to 1	....do ...	2.4	19.4	....do ...	Mar. 26
11	Section 3	8	3 to 1	3 to 1	....do ...	2.7	19.1	....do ...	Do.
12	Section 4	8	3 to 1	3 to 1	....do ...	3.3	19	....do ...	Do.
13	Section 5	8	3 to 1	3 to 1	....do ...	3	18.6	....do ...	Do.
14	Section 6	8	3 to 1	3 to 1	....do ...	3.1	18.4	....do ...	Jan. 17
15	St. Claude	8	3 to 1	3 to 1	....do...	4.6	17.6	1898. Jan. 5	(Part.)

Fourth district levees, 1897-98—Continued.

ATCHAFALAYA LEVEE DISTRICT—Continued.

No.	Name of levee.	Total yardage paid for.	Price per cubic yard.	Total cost.	Distance from center of levee to river bank.			Nature of bank
					Least.	Greatest.	Average.	
		Cu. yds.	*Cents.*		*Feet.*	*Feet.*	*Feet.*	
1	Raccourci	85, 136. 52	12	$4, 216. 88	896	660	500	Caving.
2	Raccourci to Longwood, section 9	6, 717. 65	9	604. 59	22, 000	23, 500	22, 800	Stationar
3	Fleta, section 1	17, 853. 22	18	3, 213. 58	870	860	700	Caving.
	Morrison:							
4	Section 5	18, 779. 72	13. 75	2, 582. 21	1, 150	1, 200	1, 175	Forming.
5	Section 6	17, 867. 81	13. 75	2, 456. 82	1, 150	1, 200	1, 175	Do.
6	Section 8	18, 909. 49	13. 75	2, 600. 05	700	1, 200	1, 100	Do.
	Point Coupee:							
7	Section 1	14, 769. 05	13. 75	2, 030. 74	160	230	190	Caving.
8	Section 3	14, 535. 71	13. 75	1, 998. 66	176	860	200	Do.
	St. Francis Church:							
9	Section 1	15, 740. 44	16. 65	2, 620. 78	1, 160	1, 600	1, 400	Do.
10	Section 2	14, 885. 67	16. 65	2, 478. 46	1, 160	1, 200	1, 180	Do.
11	Section 3	14, 340. 20	16. 65	2, 387. 64	650	900	800	Do.
12	Section 4	14, 960. 49	16. 65	2, 490. 92	650	820	750	Do.
13	Section 5	15, 507. 71	16. 65	2, 582. 03	680	700	690	Do.
14	Section 6	16, 152. 88	16. 65	2, 689. 45	270	670	470	Washing caving.
15	St. Claude	25, 000. 00	16. 25	4, 062. 50	200	960	600	Washing

LAFOURCHE LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Gra le ab hig kn wa
					Feet.	*Feet.*	*F*
1	Sections 11, 12, and 13	888	R.	Donovan & Daley	8, 354	3, 700	
2	Sections 21, 22, and 23	892	R.	do	4, 407	4, 585	
3	Sections 24, 25, and 26	892	R.	do	3, 285	3, 294	
4	Bonsecour	905	R.	Sullivan & Curtis	4, 500	4, 400	
5	Waguespack, section 3	914	R.	James H. Cary	2, 600	2, 555	
6	White Rose	920	R.	Sullivan & Curtis	1, 617	1, 665	

No.	Name of levee.	Section.			New or enlargement.	Average height.		Date of contract.	W c pl
		Crown.	Land slope.	River slope.		Above old levee.	Ground surface.		
		Feet.				*Feet.*	*Feet.*		
1	Sections 11, 12, and 13	8	2½ to 1	3 to 1	Enlargement.	1. 5	12. 1	1896. Dec. 11	1 A
2	Sections 21, 22, and 23	8	2½ to 1	3 to 1	do	1. 8	14. 1	do	
3	Sections 24, 25, and 26	8	3 to 1	3 to 1	do	1. 3	10. 6	do	
4	Bonsecour	8	2½ to 1	3 to 1	do	1. 2	12. 5	1895. Mar. 28	A 1
5	Waguespack, section 3	8	3 to 1	3 to 1	do	.9	10. 1	1897. Dec. 27	A 1
6	White Rose	8	2½ to 1	3 to 1	do	1. 7	11. 7	1895. Mar. 28	O

Fourth district levees, 1897-98—Continued.

LAFOURCHE LEVEE DISTRICT—Continued.

No.	Name of levee.	Total yardage paid for.	Price per cubic yard.	Total cost.	Distance from center of levee to river bank.			Nature of bank.
					Least.	Greatest.	Average.	
		Cu. yds.	*Cents.*		*Feet.*	*Feet.*	*Feet.*	
1	Sections 11, 12, and 13	12, 633. 67	9. 33⅓	$1, 181. 95	157	450	316	Caving and washing.
2	Sections 21, 22, and 23	13, 376. 09	9. 33⅓	1, 248. 43	112	251	185	Washing.
3	Sections 24, 25, and 26	13, 866. 97	9. 33⅓	1, 294. 25	65	151	101	Do.
4	Bonsecour	14, 406. 37	9. 89	1, 424. 79	165	560	289	Washing and caving.
5	Waguespack, section 3	15, 845. 63	10. 00	1, 584. 56	126	165	146	Washing.
6	White Rose	8, 527. 77	9. 89	843. 39	273	370	326	Stationary and caving.

BARATARIA LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
					Feet.	*Feet.*	*Feet.*
1	Belle Chase to St. Ann	984	R	Thos. Egan, jr	3, 582	3, 573	2. 0
2	St. Ann to Concession	985	R	.....do	4, 957	4, 915	1. 9
	Ballay to Orange Farm:						
3	Section 1	1, 022	R	Victor Adema	2, 269	2, 239	2. 5
4	Section 2	1, 022	R	.....do	2, 465	2, 455	2. 5
5	Section 6	1, 022	R	W. J. Bentley & Co	1, 608	1, 583	2. 6
6	Section 7	1, 022	R	.....do	2, 100	2, 071	2. 6

No.	Name of levee.	Section.			New or enlargement.	Average height.		Date of contract.	Work completed.
		Crown.	Land slope.	River slope.		Above old levee.	Ground surface.		
		Feet.				*Feet.*	*Feet.*	1896.	1897.
1	Belle Chase to St. Ann	8	2½ to 1	3 to 1	Enlargement.	0. 2	7. 3	Aug. 11	Aug. 7
2	St. Ann to Concession	8	2½ to 1	3 to 1	....do	.6	7. 1	....do	Do.
	Ballay to Orange Farm:							1897.	1898.
3	Section 1	8	3 to 1	3 to 1	New	1. 7	6. 5	Sept. 17	Feb. 12
4	Section 2	8	3 to 1	3 to 1	Enlargement.	2. 4	6. 5	....do	Do.
5	Section 6	8	3 to 1	3 to 1	New	1. 9	7. 4	....do	Apr. 11
6	Section 7	8	3 to 1	3 to 1	Enlargement.	1. 9	7. 4	....do	Do.

No.	Name of levee.	Total yardage paid for.	Price per cubic yard.	Total cost.	Distance from center of levee to river bank.			Nature of river bank.
					Least.	Greatest.	Average.	
		Cu. yds.	*Cents.*					
1	Bell Chase to St. Ann	3, 298. 77	13. 00	$428. 84	44	196	97	Washing.
2	St. Ann to Concession	6, 209. 07	13. 00	807. 18	47	162	107	Sloping.
	Ballay to Orange Farm:							
3	Section 1	15, 897. 39	11. 25	1, 788. 45	45	140	117	Permanent.
4	Section 2	11, 529. 41	11. 25	1, 297. 06	36	80	57	Do.
5	Section 6	15, 342. 48	14. 25	2, 186. 31	191	220	211	Caving.
6	Section 7	22, 081. 64	14. 25	3, 146. 63	201	290	253	Do.

Fourth district levees, 1897–98—Continued.

PONTCHARTRAIN LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Gra le ab hig kn wa
					Feet.	*Feet.*	*F*
1	Section 1	835	L.	Hearin & O'Connor	1,849	1,200	
2	Section 2	835	L.	.....do	1,751	1,750	
3	Section 3	835	L.	.....do	1,690	1,680	
4	Section 4	836	L.	.....do	1,433	1,430	
5	Section 5	836	L.	.....do	1,717	1,710	
6	Section 6	836	L.	I. R. Bobbitt	1,254	1,200	
7	Section 8	836	L.	.....do	1,946	1,930	
8	Section 17	839	L.	Michael Hanick	1,193	1,190	
9	Section 18	839	L.	.....do	1,800	1,800	
10	Conrad	839	L.	I. R. Bobbitt	1,728	1,900	
11	Section 23	840	L.	Michael Hanick	2,045	3,400	
12	Section 26	840	L.	.....do	1,214	1,050	
13	Section 27	840	L.	.....do	2,063	1,950	
14	Section 28	843	L.	.....do	1,526	1,500	
15	Section 29	843	L.	.....do	1,432	1,430	
16	Section 30	843	L.	.....do	1,501	1,390	
17	Section 31	843	L.	.....do	1,310	1,310	
18	Section 32	844	L.	.....do	1,301	1,300	
19	Section 33	844	L.	.....do	1,204	1,200	
20	Section 36	845	L.	.....do	1,224	1,220	
21	Section 37	846	L.	.....do	1,391	1,390	
22	Section 38	846	L.	.....do	1,242	1,240	
23	Section 39	846	L.	.....do	1,072	1,070	
24	Section 40	846	L.	.....do	1,022	1,020	
	Gomez:						
25	Section 1	855	L.	Jordan Bros	1,500	1,800	
26	Section 2	855	L.	George Byrne	1,566	1,850	
27	Tippecanoe	894	L.	Hearin & O'Connor	4,961	4,950	
28	Whitehall	896	L.	.....do	590	620	

No.	Name of levee.	Section.			New or enlargement.	Average height.		Date of contract.	W c pl
		Crown.	Land slope.	River slope.		Above old levee.	Ground surface.		
		Feet.				*Feet.*	*Feet.*	1897.	1
1	Section 1	8	3 to 1	3 to 1	Enlargement.	1.2	13	Sept. 1	A
2	Section 2	8	3 to 1	3 to 1	....do	1.5	16.5	....do	A
3	Section 3	8	3 to 1	3 to 1	....do	2.3	18	....do	Ja 1
4	Section 4	8	3 to 1	3 to 1	....do	2.6	15.2	....do	D 1
5	Section 5	8	3 to 1	3 to 1	....do	2.7	16.5	....do	F 1
6	Section 6	8	3 to 1	3 to 1	....do	3.5	21.5	....do	D
7	Section 8	8	3 to 1	3 to 1	....do	1.6	18	....do	N 1
8	Section 17	8	3 to 1	3 to 1	....do	1.2	14.4	....do	A
9	Section 18	8	3 to 1	3 to 1	....do	1	13.9	....do	
10	Conrad	8	3 to 1	3 to 1	New	....	14.6	Dec. 27	A
11	Section 23	8	3 to 1	3 to 1	Enlargement.	2.8	14.6	Sept. 1	
12	Section 26	8	3 to 1	3 to 1	....do	2.9	16.3	....do	A 1
13	Section 27	8	3 to 1	3 to 1	....do	2.8	15.6	....do	D 1
14	Section 28	8	3 to 1	3 to 1	....do	3.3	13.5	....do	M
15	Section 29	8	3 to 1	3 to 1	....do	3	15.4	....do	F
16	Section 30	8	3 to 1	3 to 1	....do	3	16.1	....do	A 1
17	Section 31	8	3 to 1	3 to 1	....do	3	16.8	....do	D 1
18	Section 32	8	3 to 1	3 to 1	....do	2.8	17.7	....do	J
19	Section 33	8	3 to 1	3 to 1	....do	2.7	18	....do	F 1
20	Section 36	8	3 to 1	3 to 1	....do	2.4	14	....do	D
21	Section 37	8	3 to 1	3 to 1	....do	2.5	14	....do	D 1
22	Section 38	8	3 to 1	3 to 1	....do	2.4	13	....do	M
23	Section 39	8	3 to 1	3 to 1	....do	2.8	12.9	....do	F

Fourth district levees, 1897-98—Continued.

PONTCHARTRAIN LEVEE DISTRICT—Continued.

No.	Name of levee.	Section.			New or enlargement.	Average height.		Date of contract.	Work completed.
		Crown.	Land slope.	River slope.		Above old levee.	Ground surface.		
		Feet.				*Feet.*	*Feet.*	1897.	1898.
24	Section 40	8	3 to 1	3 to 1	Enlargement.	2.2	12.6	Sept. 1	Feb. 10
	Gomes:								1897.
25	Section 1	8	3 to 1	3 to 1	New		10	Feb. 1	Aug. 7
26	Section 2	8	3 to 1	3 to 1	do		10	do	Aug. 16
27	Tippecanoe	8	2½ to 1	3 to 1	Enlargement.	2.4	10.4	1896. Aug. 29	Aug. 26
28	Whitehall	8	2½ to 1	3 to 1	do	2	10	do	Do.

No.	Name of levee.	Total yardage paid for.	Price per cubic yard.	Total cost.	Distance from center of levee to river bank.			Nature of river bank.
					Least.	Greatest.	Average.	
		Cub. yds.	*Cents.*		*Feet.*	*Feet.*	*Feet.*	
1	Section 1	15,774.21	14.50	$2,287.26	230	270	250	Stationary.
2	Section 2	15,657.29	14.50	2,270.31	300	390	335	Washing.
3	Section 3	19,506.22	13.50	2,633.34	260	300	280	Do.
4	Section 4	15,786.33	13	2,052.22	275	310	295	Caving slowly.
5	Section 5	19,407.90	13	2,523.02	310	410	360	Do.
6	Section 6	17,158.28	17	2,916.90	310	673	500	Caving.
7	Section 8	21,088.64	17	3,585.07	524	673	600	Do.
8	Section 17	10,195.72	10.99	1,120.51	175	260	220	Do.
9	Section 18	15,539.26	10.99	1,707.76	212	380	340	Do.
10	Conrad	38,680.46	14	5,415.26	370	830	400	Forming.
11	Section 23	25,490.08	10.99	2,801.86	70	860	510	Do.
12	Section 26	16,215.92	10.99	1,782.13	510	750	650	Do.
13	Section 27	28,336.98	10.99	3,114.24	110	720	400	Do.
14	Section 28	16,988.35	10.99	1,867.02	260	328	300	Do.
15	Section 29	18,202.67	10.99	2,000.47	193	287	245	Washing.
16	Section 30	16,556.51	10.99	1,819.56	232	380	250	Do.
17	Section 31	14,725.66	10.99	1,618.35	375	470	430	Washing and caving.
18	Section 32	13,094.98	10.99	1,439.14	346	460	420	Caving.
19	Section 33	11,699.47	10.99	1,285.77	350	480	420	Do.
20	Section 36	9,984.56	10.99	1,097.30	328	418	370	Subsiding.
21	Section 37	12,406.77	10.99	1,363.50	340	460	400	Washing.
22	Section 38	11,474.58	10.99	1,261.06	347	400	350	Do.
23	Section 39	10,573.87	10.99	1,162.07	338	347	340	Do.
24	Section 40	8,732.36	10.99	959.69	338	357	350	Do.
	Gomes:							
25	Section 1	21,906.60	8.15	1,785.39	180	240	200	Forming.
26	Section 2	22,445.66	7.92	1,777.70	140	220	190	Do.
27	Tippecanoe	22,553.60	8.40	1,894.50	140	190	170	Washing.
28	Whitehall	2,666.77	8.45	225.34	385	470	430	Stationary.

LAKE BORGNE LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
	Story to Caernarvon:				*Feet.*	*Feet.*	*Feet.*
1	Section 1	975	L.	W. F. Barbour & Son	2,186	2,161	2.9
2	Section 2	976	L.	do	4,400	4,453	2.9
3	Section 5	977	L.	John F. Meyer	1,600	1,523	2.8
4	Section 6	977	L.	do	2,125	2,070	2.8
5	St. Clair	982	L.	Chas. G. Daunoy	9,640	10,219	2.8
6	Greenwood	990	L.	do	4,852	5,030	2.6
7	Woodlawn	992	L.	do	7,984	7,951	2.5

Fourth district levees, 1897-98—Continued.

LAKE BORGNE LEVEE DISTRICT—Continued.

No.	Name of levee.	Section.			New or enlargement.	Average height.		Date of contract.	Work com- pleted
		Crown.	Land slope.	River slope.		Above old levee.	Ground surface.		
	Story to Caernarvon:	*Feet.*				*Feet.*	*Feet.*	1897.	1898.
1	Section 1	8	3 to 1	3 to 1	Enlargement.	1.9	9.8	Sept. 17	Mar.
2	Section 2	8	3 to 1	3 to 1	....do ...	1.6	9.8	....do ..	Do.
3	Section 5	8	3 to 1	3 to 1	....do ...	1.6	9.8	Dec. 10	Feb.
4	Section 6	8	3 to 1	3 to 1	....do ...	1.4	9.8	....do ...	Apr.
5	St. Clair	8	2½ to 1	3 to 1	....do ...	.9	6.8	1896. Oct. 26	(Part.
6	Greenwood	8	2½ to 1	3 to 1	....do ...	.6	9.5	....do ...	Mar.
7	Woodlawn	8	2½ to 1	3 to 1	....do ...	.5	7.1	....do ...	1897. Oct.

No.	Name of levee.	Total yardage paid for.	Price per cubic yard.	Total cost.	Distance from center of levee to river bank.			Nature of river bank.
					Least.	Greatest.	Average.	
	Story to Caernarvon:	*Cu. yds.*	*Cents.*		*Feet.*	*Feet.*	*Feet.*	
1	Section 1	9,439.95	14.45	$1,364.08	125	314	185	Washing.
2	Section 2	25,029.95	14.45	3,616.83	250	545	397	Caving.
3	Section 5	7,489.97	12.50	936.25	120	170	141	Do.
4	Section 6	8,967.00	12.50	1,120.88	87	200	138	Do.
5	St. Clair	15,051.23	11.40	1,715.84	80	655	400	Sloughing,makin
6	Greenwood	14,486.20	11.40	1,651.42	168	290	241	Sloughing, cavin
7	Woodlawn	10,937.17	11.40	1,246.84	70	200	175	Making.

Summary of levees built from May 1, 1897, to May 1, 1898.

	Lower Tensas Levee district.	Atchafalaya Levee district.	Lafourche Levee district.	Barataria Levee district.	Pontchartrain Levee district.	Lake Borgne Levee district.	Total.
Earthwork ...cubic yds..	1,014,257.13	261,156.56	78,656.50	74,358.76	472,849.70	91,401.47	1,992,680.
Embankment..linear ft..	92,668	19,990	19,763	16,981	44,025	32,787	226,214
Axis of river covered, linear feet	111,596	18,435	20,199	16,836	45,470	33,387	245,913

Statement of yardage of levee work constructed by the United States and others in t Fourth district, Mississippi River.

	Levee districts.					
	Lower Tensas.	Atchafalaya.	Lafourche.	Barataria.	Pontchartrain.	Lake Borgn
	Cu. yds.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yd*
Aggregate number of cubic yards in levees on the Mississippi River May 1, 1897	12,927,065	13,890,122	6,583,042	2,098,008	11,137,516	2,485,
Added by the United States up to May 1, 1898	1,014,257	261,157	78,657	78,359	472,850	91,
Added up to May 1, 1898, by State and district levee boards	475,966	1,297,167	283,923	203,446	372,192	59,
Total	14,417,288	15,448,446	6,945,622	2,379,813	11,982,558	2,635,
Lost by abandonment from May 1, 1897, to May 1, 1898:						
By the United States	32,418				20,604	
By the State and others	75,200	169,404	140,385			
Aggregate remaining May 1, 1898	14,309,670	15,279,042	6,805,237	2,379,813	11,961,954	2,635,

Percentage of length of existing levee system built in whole or in part by the United States.

	Per cent.
Lower Tensas Levee district	66
Atchafalaya Levee district	65
Lafourche Levee district	61
Barataria Levee district	50
Pontchartrain Levee district	75
Lake Borgne Levee district	65
Percentage of total length of existing levee system, Fourth district, Mississippi River improvement, built in whole or in part by the United States	65

LOWER TENSAS LEVEE DISTRICT.

The amount expended from June 30, 1897, to June 30, 1898, is $173,155.02, distributed as follows:

Office expenses (main office)	$4,259.51
Other administrative expenses	12,096.98
Construction of levees (contracts)	145,445.08
Repairs to levees	3,958.95
Surveys	3,245.18
Repairs to plant	64.06
Care of plant	198.82
New plant	555.15
Protection of levees	3,331.29
Total	173,155.02

Money statement.

July 1, 1897, balance unexpended		$34,136.93
Amount allotted from appropriation act of June 4, 1897		228,700.00
Amount allotted from appropriation act of July 19, 1897		45,000.00
		* 307,836.93
June 30, 1898, amount expended during fiscal year		173,155.02
July 1, 1898, balance unexpended		134,681.91
July 1, 1898, outstanding liabilities	$233.00	
July 1, 1898, amount covered by uncompleted contracts	67,353.49	
		67,586.49
July 1, 1898, balance available		67,095.42

ATCHAFALAYA LEVEE DISTRICT.

The amount expended from June 30, 1897, to June 30, 1898, is $55,400.69, distributed as follows:

Office expenses (main office)	$4,440.37
Other administrative expenses	6,352.97
Construction of levees (contracts)	41,298.50
Repairs to levees	3,087.45
Surveys	172.49
Repairs to plant	
Care of plant	11.01
New plant	37.90
Protection of levees	
Total	55,400.69

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* Balance unexpended July 1, 1897, as stated in previous report, $312,486.93; difference is due to change in allotment after date of report.

Money statement.

Amount allotted from appropriation, act of June 4, 1897		$138, 600.
Amount allotted from appropriation, act of July 19, 1897		28, 125.
		166, 725.
Less amount overdrawn		3, 488
		* 163, 236.
June 30, 1898, amount expended during fiscal year		55, 400.
July 1, 1898, balance unexpended		107, 835.
July 1, 1898, outstanding liabilities	$522. 09	
July 1, 1898, amount covered by uncompleted contracts	86, 123. 39	
		86, 645.
July 1, 1898, balance available		21, 189.

LAFOURCHE LEVEE DISTRICT.

The amount expended from June 30, 1897, to June 30, 1898, is $12,327.62, distribut as follows:

Office expenses (main office)	$3, 533.
Other administrative expenses	1, 168.
Construction of levees (contracts)	7, 534.
Repairs to levees	9.
Surveys	26.
Repairs to plant	2.
Care of plant	15.
New plant	37.
Total	12, 327.

Money statement.

July 1, 1897, balance unexpended		$6, 345.
Amount allotted from appropriation, act of June 4, 1897		41, 600.
Amount allotted from appropriation, act of July 19, 1897		8, 437.
		† 56, 382.
June 30, 1898, amount expended during fiscal year		12, 327.
July 1, 1898, balance unexpended		44, 055.
July 1, 1898, outstanding liabilities	$166. 50	
July 1, 1898, amount covered by uncompleted contracts	27, 501. 75	
		27, 668.
July 1, 1898, balance available		16, 386.

BARATARIA LEVEE DISTRICT.

The amount expended from June 30, 1897, to June 30, 1898, is $19,447.03, distribut as follows:

Office expenses (main office)	$36.
Other administrative expenses	3 715.
Construction of levees (contracts)	10, 925.
Repairs to levees	4, 583.
Surveys	107.
Repairs to plant	9.
Care of plant	7.
New plant	29.
Protection of levees	33.
Total	19, 447.

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* Balance unexpended July 1, 1897, as stated in previous report, $165,261.01; d ference is due to change in allotment after the date of the report.

† Balance unexpended July 1, 1897, as stated in previous report, $56,970.17; diff ence due to change in allotment after the date of the report.

Money statement.

July 1, 1897, balance unexpended		$17,309.06
Amount allotted from appropriation, act of June 4, 1897		19,400.00
Amount allotted from appropriation, act of July 19, 1897		3,937.50
		* 40,646.56
June 30, 1898, amount expended during fiscal year		19,447.03
July 1, 1898, balance unexpended		21,199.53
July 1, 1898, outstanding liabilities	$42.50	
July 1, 1898, amount covered by uncompleted contracts	14,399.87	
		14,442.37
July 1, 1898, balance available		6,757.16

PONTCHARTRAIN LEVEE DISTRICT.

The amount expended from June 30, 1897, to June 30, 1898, is $65,385.49, distributed as follows:

Office expenses (main office)	$898.50
Other administrative expenses	3,634.88
Construction of levees (contracts)	56,611.80
Repairs to levees	2,884.58
Surveys	937.24
Repairs to plant	17.33
Care of plant	10.00
New plant	0.00
Protection of levees	391.16
Total	65,385.49

Money statement.

July 1, 1897, balance unexpended		$2,985.71
Amount allotted from appropriation, act of June 4, 1897		113,150.00
Amount allotted from appropriation, act of July 19, 1897		22,500.00
		† 138,635.71
June 30, 1898, amount expended during fiscal year		65,385.49
July 1, 1898, balance unexpended		73,250.22
July 1, 1898, outstanding liabilities	$263.58	
July 1, 1898, amount covered by uncompleted contracts	66,090.61	
		66,354.19
July 1, 1898, balance available		6,896.03

LAKE BORGNE LEVEE DISTRICT.

The amount expended from June 30, 1897, to June 30, 1898, is $18,672.24, distributed as follows:

Office expenses (main office)	$74.16
Other administrative expenses	2,893.05
Construction of levees (contracts)	13,071.81
Repairs to levees	2,385.56
Surveys	233.41
Repairs to plant	14.00
Care of plant	0.00
New plant	.25
Protection of levees	0.00
Total	18,672.24

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* Balance unexpended July 1, 1897, as stated in previous report, $40,934.06; difference is due to change in allotment after the date of the report.

† Balance unexpended July 1, 1897, as stated in previous report, $140,660.71; difference is due to change in allotment after the date of the report.

Money statement.

July 1, 1897, balance unexpended		$14,337.3
Amount allotted from appropriation act of June 4, 1897		22,200.0
Amount allotted from appropriation act of July 19, 1897		4,500.0
		*41,037.3
June 30, 1898, amount expended during fiscal year		18,672.2
July 1, 1898, balance unexpended		22,365.0
July 1, 1898, outstanding liabilities	$42.44	
July 1, 1898, amount covered by uncompleted contracts	10,093.90	
		10,136.3
July 1, 1898, balance available		12,228.7

PRESERVATION OF WORKS.

The amount expended on account of high water from June 30, 1897, to June 3 1898, is $24,076.36, distributed as follows:

Office expenses (main office)	$3,325.5
Other administrative expenses	1,985.2
Labor	5,829.7
Material	1,424.3
Steamers	3,481.3
Fuel	618.3
Repairs to plant	2,461.7
Care of plant	127.2
New plant	1,008.0
Warehouses	3,814.8
Total	24,076.3

Money statement.

July 1, 1897, balance unexpended	$24,076.3
June 30, 1898, amount expended during fiscal year	24,076.3

The following maps and appendixes accompany this report:

PLATE I. Natchez and Vidalia harbors.
II. New Orleans Harbor (Algiers Point).
III. Lower Tensas and Homochitto Levee districts.
IV. Atchafalaya, Lafourche, and Pontchartrain Levee districts.
V. Barataria and Lake Borgne Levee districts.
APPENDIX A. Statement of value of plant.
B. Commercial statistics.
C. List of civilian engineers.
D. Report of H. S. Douglas, assistant engineer, on Natchez and Vidalia harbors.
E. Report of H. S. Douglas, assistant engineer, on repairs to plant.
F. Report of A. F. Woolley, jr., assistant engineer, on Atchafalay and Red rivers.
G. Report of W. J. Hardee, assistant engineer, on levees.
H. Abstract of proposals.
I. Abstract of contracts in force.

Very respectfully, your obedient servant,

GEO. McC. DERBY,
Captain of Engineers, U. S. A.

Col. G. L. GILLESPIE,
Corps of Engineers, U. S. A.,
President Mississippi River Commission.

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*Balance unexpended July 1, 1897, as stated in previous report, $41,336.30 difference is due to change in allotment after the date of the report.

APPENDIX 4 A.

Approximate value of plant belonging to the United States and used upon the improvement of the Mississippi River, Fourth district, May 1, 1898.

Class of property.	Value.	Class of property.	Value.
Steam launch Ruby	$3,000	29 skiffs	$400
Tug General Comstock	6,000	Tools and appliances	20,000
Tug Tilda	4,000	Office furniture	3,500
Dredge The Ram	45,000	Surveying instruments	4,000
1 pile driver	1,000	Drawing instruments	200
5 quarter boats	13,000	Railway cars and track	1,000
25 barges	40,000		
1 warehouse barge	1,000	Total	143,100
1 dry dock	1,000		

APPENDIX 4 B.

Foreign commerce, port of New Orleans.

[The statistics relating to the foreign commerce of the port of New Orleans were kindly furnished by Hon. Theo. S. Wilkinson, collector of customs.]

Vessels.	Entrances.			Clearances.		
	1895–96.	1896–97.	1897–98.	1895–96.	1896–97.	1897–98.
Steam	812	1,236	1,282	841	1,232	1,287
Sail	69	72	65	44	56	61
Total	881	1,308	1,347	885	1,288	1,348

Total tonnage of above.

1895–96	2,140,396
1896–97	3,774,688
1897–98	4,236,668

Exports and imports.

	1896.	1897.	1898.
Exports:			
Total value of exports of foreign merchandise to foreign countries	$272,107.00	$303,319.00	$546,378.00
Total value of exports of domestic merchandise to foreign countries	80,837,794.00	98,513,917.00	104,965,121.00
Total	81,109,901.00	98,817,236.00	105,511,499.00
Imports:			
Total value of imports from foreign countries—			
Free	9,405,403.00	9,357,466.00	5,916,768.00
Dutiable	4,978,500.00	5,409,332.00	5,934,902.00
Transit to Mexico		921,015.00	949,070.00
Transported to interior ports		1,184,048.00	811,427.00
Specie	469,161.00	615,571.00	539,344.00
Total	14,853,064.00	17,487,432.00	14,151,511.00
Total duties collected	1,602,183.82	2,039,146.73	2,200,275.44

APPENDIX 4 C.

List of civilian engineers employed on work of river and harbor improvements, Fourth district, improving Mississippi River, from May 1, 1897, to May 1, 1898, in charge of Capt. Geo. McC. Derby, Corps of Engineers.

Name and residence.	Time employed.	Compensation per month.	Where employed.	Work on which employed.
	Months.			
H. S. Douglas, New Orleans, La.	12	$200	Natchez, Miss., and New Orleans, La.	Improving harbors at Natche and Vidalia, Miss., and harbor at New Orleans, La.
W. J. Hardee, New Orleans, La.	$1\frac{24}{30}$ $10\frac{6}{30}$	200 225	New Orleans, La	Levees, Lower Tensas, Atchafalaya, Lafourche, Barataria, Pontchartrain, and Lake Borgne Levee districts.
E. B. Geddes, Natchez, Miss.	12	150	Natchez, Miss.	Improving harbors at Natche and Vidalia, Miss. and La.
A. F. Woolley, jr., New Orleans, La.	12	150	New Orleans, La., and Old River, La.	Surveys, gauges, and observations improving Atchafalaya and Red Rivers, Louisiana.

APPENDIX 4 D.

REPORT OF ASSISTANT ENGINEER H. S. DOUGLAS, IN LOCAL CHARGE OF IMPROVING HARBORS AT NATCHEZ AND VIDALIA, MISSISSIPPI AND LOUISIANA.

NEW ORLEANS, LA., *May 1, 1898.*

SIR: I have the honor to submit the following report on the work of improving the harbors at Natchez and Vidalia, Mississippi and Louisiana, for the period fro May 1, 1897, to date.

At date of last report the only work in progress at this locality, the enlargemen of the spur levee on Cowpen Neck, had been suspended on account of high water. A portion of the necessary plant for bank protection work, consisting of a quarte boat and several barges, had been laid up near the scene of the proposed work i Giles Bend, after being used to assist in the maintenance of the levees during the flood. By contract and purchase 10,195 tons of rock had been obtained and stored on the bank at the upper end of Giles Bend. Estimates of material required fo spur-dike construction were being made and the plant generally overhauled and pu in good condition.

On June 17 the river had fallen sufficiently to allow the contractors to continu the enlargement of the spur levee on Cowpen Neck. This work was completed o October 23, 87,654.69 cubic yards of earth being placed in the levee at a cost o $10,518.54. The flood of 1897 had greatly damaged the outer end of the levee and the revetment. The earth that had been washed away was replaced and a short spu levee built out from the main line to check the current. The rock revetment at the outer end was repaired and 101 tons rock added to the pavement. The total cost o work on the levee, enlargement and repairs was $11,008.48.

The most important work was, of course, the protection of the caving bank i Giles Bend on the north side of Cowpen Neck. A project had been approved fo the construction of 14 submerged sloping-spur dikes, placed at intervals of 450 feet. Each dike consisted of a foundation mattress 150 feet wide and 300 feet long, and 2 cribs respectively 6 by 24 by 200 feet and 6 by 16 by 250 feet. The mattress and cribs were of the same type as those used in New Orleans Harbor last year. For 25 feet above and 25 feet below the center line of each spur the bank from low-wate mark up was graded to a slope of about 3 to 1, and paved a little above a two-thirds stage of the river. The pavement was about 8 inches thick. In addition to thi the crib work of each spur was prolonged to the top of the paved bank by a line o cypress piles spaced about 12 inches apart, driven 20 feet, and projecting 12 fee above the slope.

Shortly after the construction had commenced the Mississippi River Commissio made an additional allotment for the work, and the construction of about 22 mor spur dikes was authorized.

On July 27, the steamer *Osceola* and tug *General Comstock,* with the quarter boat *New Orleans* and 4 barges loaded with lumber, etc., left New Orleans for Giles Bend. The nucleus of a force consisting of 76 men had been organized and were on the quarter boat. The tow arrived at the willow bar in front of Quitman's Landing, just above Giles Bend, on August 2, and the construction of ways and cutting o willows was commenced the same day. Construction of mattresses and cribs was commenced August 7 and completed December 10, between which dates 682,900 square feet of mattress and 816,000 cubic feet of cribs were built.

Everything progressed favorably, and on September 8 a well-organized force of 250 men was at work; 240,000 square feet of mattress and 105,600 cubic feet of cribs had been built and were ready for sinking. In the meanwhile the unfortunate yellow-fever scare or panic was rapidly spreading, and on September 15 two quarantine guards arrived on the works and stated that no one was to be allowed to leave, as it was reported that a man had died on one of the quarter boats with black vomit. These guards represented the local health authorities, and from this time until December 1 the work was carried on under difficulties and embarrassment of which no description can give a realizing sense. I succeeded, after great difficulty, in proving to the local health authorities that there was no yellow fever on the works.

Arrangements were made to employ a local physician to act as health officer on the quarter boats. A rigid, nonintercourse quarantine against all infected localities was adopted, and friendly relations with the health authorities cultivated. By these means the work was kept going, not to the best advantage, but it was kept going when almost everything else had been stopped. As no new men could be brought to the work, local labor, principally negroes, were all that could be had. This labor was very inefficient, and, knowing that other men could not be obtained, were very independent. On September 28 the laborers stopped work and demanded higher pay. This trouble was met and overcome, as was the quarantine difficulty, by the exercise of policy and discretion. The matter was so arranged that while the increase was nominally granted the United States suffered no loss, and ultimately the old rate of wages was restored without jar, friction, or delay to the work. Supplies were obtained from Natchez, although at times the regular means of communication were so badly crippled by quarantine regulations that meat, ice, etc., had to be hauled in wagons overland to the works. From October 1 to December 1 the force employed varied from 100 to 200 men. As our organization contemplated operating 300 men, it appeared almost impossible to carry on operations economically. Yet, as the result shows, the work was actually done for less than ever before.

Construction may be said to have commenced on July 27, when the quarter boat, with a small organized force, left New Orleans for Giles Bend. Actual construction did not commence until August 2, when the quarter boat, lumber, barges, etc., arrived at the willow bar just above Giles Bend. The cost of towage, subsistence, and services during this time, which I consider installation expenses, amounted to $2,000.

All of the mattresses and cribs used during the past season were constructed on two sets of ways built on the willow bar that has made below Fairchilds Chute and in front of Quitmans Landing. The cost of these ways was $668.24, as follows:

36,020 B. M. lumber	$246.74
1,200 pounds 6-inch steel wire nails	20.64
200 pounds 4-inch steel wire nails	3.44
Subsistence, including service	109.93
Labor, superintendence, etc	287.49
Total	668.24

All the willows required were cut in the vicinity of the ways and hauled, as needed, in wagons. The area from which the willows were cut was 234 acres, and the total number of cords of willow brush and poles used was 11,036. The detailed cost was:

Cutting, hauling, etc	$6,428.74
Subsistence, including service	1,509.46
234 acres of land, at $1	234.00
Total	8,172.20
Cost per cord, delivered alongside of ways	$0.7405

The cost of subsistence was somewhat increased from causes that were the outcome of quarantine regulations.

Provisions, including ice, freight, etc	$9,601.74
Service	3,496.41
Total	13,098.15
Number of men subsisted	36,000
Cost of raw ration	$0.266
Cost served	$0.364
Cost served, per day's labor secured	$0.497

The total cost of constructing the mattresses and cribs, including installatio
building ways, etc., was $35,565.87, divided as follows:

Mattress.

220,325 feet B. M., 2 by 4 inch lumber, at $6.50	$1,570.
72,941 feet B. M., 3 by 6 inch lumber, at $6.85	499.
6,500 pounds 9-inch steel wire nails, at $0.0172	111.
17,000 pounds 6-inch steel wire nails, at $0.0172	292.
3,000 pounds 4-inch steel wire nails, at $0.0172	51.
6,000 pounds No. 10 wire	103.
Miscellaneous, oils, fuel, etc	618.
Subsistence, including service	5,375.
Labor, superintendence, etc	13,015.
Total	21,638.

Cribs.

143,690 feet B. M., 3 by 6 inch lumber, at $6.85	$984.
10,600 pounds 9-inch steel wire nails, at $0.0172	182.
3,200 pounds 6-inch steel wire nails, at $0.0172	55.
1,500 pounds No. 10 wire	25.
Miscellaneous, oils, fuel, etc	452.
Subsistence, including service	3,550.
Labor, superintendence, etc	8,677.
Total	13,927.
Cost per square foot for mattress at ways	$0.03
Cost per cubic foot for cribs at ways	$0.01

Willow brush is included in subsistence and labor, as these two items are t
principal expense.

As the distance between where the mattresses and cribs were built and where th
were to be sunk was only about 3 miles, no charge is made for towage, as no work
this kind, strictly speaking, was done. The cribs and mats were pulled off the wa
by the tug and dropped to the point selected for mooring them until ready to sin
and again moved in between the lowering barges; but the cost of this belongs
construction and sinking.

The sinking of the mattresses and cribs was commenced September 16, temporar
suspended October 15, and recommenced November 10. The last crib was sunk
January 4. The total cost was $18,333.85.

The cost per square foot of mattress in place was $0.0496, being $0.0317 for co
struction and $0.0179 for sinking.

The cost per cubic foot of cribs in place was $0.0245, being $0.0177 for constructi
and $0.0068 for sinking.

ROCK.

The rock used for ballasting the mattresses and cribs was obtained from Gra
Gulf, Miss., from Haynes Bluff, on the Yazoo River, and from the Ohio River, at
uniform price of $1.64 per ton, delivered on the bank. The total amount deliver
was 10,195 tons, valued at $16,719.80, divided as follows:

851 tons on revetment at end of Cowpen Neck levee	$1,395.
3,012 tons ballasting mattresses	4,939.
1,909 tons ballasting cribs	3,130.
2,420 tons paving bank at end of spurs	3,968.
2,003 tons on hand	3,284.
10,195 tons	16,719.

GRADING, PAVING, AND PILE DRIVING.

The extreme oscillation of the river at this locality is over 50 feet, and the proje
provided for extending the spurs from low-water mark up to about the top of t
natural bank.

The method used was to grade the bank to a slope of about 3 to 1 for a width
50 feet at each spur 25 feet above and below the center line. This slope was th
paved from the edge of the mattress up to a point somewhat higher than a two-thir
stage of the river. On this graded and paved slope a single line of piles on the pr

longation of the center line of the crib work of the spur was driven. These piles were of cypress and spaced about 1 foot apart. They were driven into the ground about 20 feet and projected above the paving about 12 feet. The object of the piling was to check the current along the bank sufficiently to prevent scour, but without reversing the current so as to form large eddies.

The general method adopted in grading was sluicing. Long troughs were built and a stream of water pumped into the upper end. The material to be removed was shoveled into the trough and carried off by the stream of water. In grading the bank about 34,027 cubic yards of earth were handled at an average cost of 8¼ cents per yard.

The rock pavement averaged 8 inches thick and 2,420 tons of rock were used. The area of bank paved was 9,138 square yards, and the cost, including rock, labor, etc., was $0.8954 per square yard.

The pile work was considerably delayed by quarantine restrictions preventing the delivery of piles. As a result, the sudden and rapid rise of the river prevented this work being done in a regular and systematic manner. The driver had to be shifted from one spur to another to keep ahead of the water, and in some cases it was impossible to do this. In consequence, the stringers were not put on the lines of piles, and on several of the spurs the completion of the pile work will have to await the low water of next season. Making an allowance for this, the cost of the piling approximates $3,007.90, or $200.53 for each spur.

As the grading of the bank was carried above the paving, the area graded exceeded the area paved by 2,100 square yards, the total surface graded being 11,238 square yards.

SURVEYS.

Owing to the rapid caving of the bank and consequent rapid changes going on in Giles Bend, surveys, in order to be of value for comparative purposes in tracing the effects of the spur dikes, had to be almost coincident with construction. A careful survey of Giles Bend has been made, and all principal points have been so marked and referenced that it is thought that a comparative survey can be made fifty years hence and the original points either identified or reestablished. The following is a summary of work done:

Length of main traverse	feet..	28,660.7
Length of ordinates measured to river bank	do...	92,934
Number of sections sounded		122
Number of soundings taken		4,841
Number of sections leveled		165
Number of level-rod readings		2,200
Length of bank actually traversed	feet..	34,000
Length of water line actually traversed	do...	11,000
Total cost of surveys, including labor and subsistence		$1,201.30

TIMBER FELLING.

As caved-in trees, snags, etc., had obstructed the work very much, it was determined to cut down all trees in the bend below the last spur of the present season, so that the work of next year would not be interfered with. Accordingly, a strip of timber averaging about 200 feet wide was cut down over the stretch where it is expected to put down other spurs. Some of the timber felled was very heavy, being from 3 to 5 feet in diameter. About 50 acres of timber was cut at a total cost of $382.89.

Fifteen spur dikes have been completed during the season just closed. The exact location of the first four spurs was a matter that was carefully considered, as the bank line was unusually rugged, deep pockets or bays and salient points alternating, without any smooth or straight bank. It was decided to locate spurs 1, 2, 3, and 4 in the pockets, as the newly placed spurs would have the advantage, for at least the first year, of being masked by the salient points above. Another reason was that the pockets or bays, if not made originally by eddy action, were at least maintained by it. By locating the spur in the pocket the eddy would be checked, whereas, if located on the point, the effect of the spur would be to increase the eddy. Of course, if the land had been of great value it would not have been practicable to adopt this plan, for in the course of time the projecting points between the spurs will cave away, leaving the spurs as the salient points.

In adopting the plan of locating the spurs in the pockets, it was not practicable to adhere rigidly to 450 feet between center lines. Spurs Nos. 1 and 2 are 700 feet apart; spurs 2 and 5, 500 feet, and 3 and 4, 400 feet. Below Spur No. 4 the bank is, or rather was, practically a smooth curve, so the remaining eleven spurs are 450 feet between centers.

The table following gives certain information of value in reference to the sev spurs:

Number of spur.	Mattress.			Cribs.			Spur commenced.	Sp co plet
	Area.	Rock used.	Per square foot.	Cubic feet.	Rock used.	Per cubic foot.		
	Sq. Ft.	*Tons.*	*Pounds.*		*Tons.*	*Pounds.*		
1	60,000	190	6.3	52,800	125	4.7	Sept. 15	Oct
2	45,000	174	7.7	52,800	94	3.6	Sept. 17	Dec
3	45,000	154	6.8	52,800	99	3.8	Sept. 21	Dec
4	37,900	126	6.7	52,800	195	7.4	Sept. 23	Jan
5	45,000	253	11.2	52,800	107	4.05	Oct. 1	Dec
6	45,000	185	8.2	52,800	141	5.3	Oct. 7	Oct
7	45,000	257	11.4	52,800	86	3.3	Nov. 10	Nov
8	45,000	182	8.9	52,800	70	2.7	Nov. 19	Nov
9	45,000	176	7.8	76,800	158	4.1	Nov. 24	Nov
10	45,000	213	9.5	52,800	152	5.8	Dec. 8	Dec
11	45,000	221	9.8	52,800	117	4.4	Dec. 11	Dec
12	45,000	244	10.8	52,800	86	3.3	Dec. 15	Dec
13	45,000	202	9	52,800	172	6.5	Dec. 20	Dec
14	45,000	247	11	52,800	144	5.5	Dec. 27	Dec
15	45,000	188	8.4	52,800	163	6.1	Dec. 30	Dec

The great length of time elapsing between the commencement and completio spurs Nos. 1, 2, 3, 4, and 5 may be remarked. The explanation of this is, first, rapid silting up of mattresses afloat necessitated that they be sunk; and, seco the danger that quarantine restrictions would cause a total suspension of work, consequent loss of all mattress work afloat. These two reasons, and the fact t mattresses are more valuable than cribs, caused me to push the sinking of the m on the spurs and omit the cribs until a later date. In case of suspension of work there was a possibility of keeping such cribs as had been built afloat, scarcely any of saving the mattresses.

The area of mattress on Spur 1 is much greater than on other spurs. The reas for this are intimately associated with one of the advantages claimed for the pres method of building mattresses and cribs at the locality where the willows are One of the benefits claimed is, that the completed structure, being afloat for some ti would have a tendency to silt up and become water-logged. As a consequence, rock would be required to ballast and sink the mattress and cribs in position. Dur last season's work in New Orleans Harbor this silting up did not take place to extent expected, but this year the results rather exceeded my expectations. September 1, when 210,000 square feet of mattress had been completed and was aflo some of the sections commenced to show signs of sinking from silting up. The p driver attached to the work was equipped with a large steam pump, and an endea was made to wash out the silt with a powerful jet, and thus keep the mats aflo The effort was not entirely successful. On September 2 one of the sections of m tresses partially sank, and with great difficulty was towed down to the general lo tion of Spur No. 1 and pushed into a deep pocket. It was moored to the bank, in a very short time sank to the bottom without one pound of rock being placed on The exact position of the center line of the spur had not been determined at the ti and while this section of mattress accomplished good in flooring the bottom of pocket, it did not obviate the necessity for the regular mattress, 150 by 300 feet.

On Spur No. 4 the area of mattress is less than on any of the other spurs. T was occasioned by the mattress being built especially to fit into a narrow, d pocket on the center line of the spur. It has been stated in previous reports t the framed mattress in use on this work can be built to fit accurately any bank li no matter how rugged.

On Spur No. 9 the first accident of the season occurred. The mattress and bott crib had been successfully sunk. The top crib, 6 by 16 by 250 feet, was loaded successfully lowered into position on top of the lower crib, but when the toggle mooring lines leading upstream were slacked away, for the purpose of pulling th in, the crib rolled off and lay alongside instead of on top of the first crib. T necessitated the sinking of another crib, making the volume of crib work on S No. 9 exceed the others by 24,000 cubic feet.

In sinking the mattress on Spur No. 12 it is supposed that the upstream edge hung up on a lot of caved-in trees, snags, etc. Presumably for this reason the ou toggle or mooring lines tore their way through the head block of the mattress, p tially wrecking it. The mattress generally went down all right, but it is suppo that the upstream edge remained hung up on the snag. At all events when the ri rose in February two or three pieces of mattress were seen below the spurs aflo One of these pieces, by a strange fatality, floated all the way down to Southpo the upper portion of New Orleans Harbor, and was there discovered partially ent gled with one of the propellers of a twin-screw steamship. From a personal inspection of this piece and from descriptions of the other, it is reasonably certain that the portion of the mattress that forms the upstream apron of the spur rolled up and broke off along the line of the crib work as a piece of paper is torn on a straight edge. An examination at low water may determine the correctness of this.

CONCLUSION.

Fifteen complete spur dikes were built during the season, containing 682,900 square feet of mattress and 816,000 cubic feet of cribs. This is the largest amount of work of this kind ever done in one season, and it was accomplished under exceptional difficulties.

The total field cost of the season's work was $67,197.89, divided as follows:

7,341 tons of rock, at $1.64	$12,039.24
11,036 cords of willows and poles, at $0.7405	8,172.20
8,478 barrels of coal	2,303.97
488,146 feet B. M. lumber, at $6.85	3,343.80
42,264 pounds steel wire nails, at $0.0172	726.94
7,600 pounds No. 10 wire, at $0.0172	130.72
800 piles, at $1.95	1,560.00
Oils, paints, waste, etc	359.64
Provisions, including ice	8,092.28
Pay rolls, services	30,469.10
Total	67,197.89

Such portions of the provisions and pay rolls as were applied to the willow force are included in the cost of willows and poles.

Total number of spur dikes built	15
Original estimated cost, $5,500 each	$82,500.00
Actual cost as above	67,197.89
Cost of work below estimate	15,302.11
Linear feet of bank protected	7,060
Cost per linear foot of bank protected	$9.52

In obtaining the length of bank protected it has been assumed that the first and last spurs will protect a distance above and below them equal to half the interval between—that is, 225 feet.

As to the success of the work it is yet too soon to express any positive opinions. It seems to be accomplishing the desired results, but nothing certain can be known until the river reaches a low stage. The cost of the work, compared with that having a similar object in view at other localities, is so absurdly low that this fact alone would prejudice those of practical experience in protecting the caving bank of the Mississippi against it. Fortunately, however, prejudice and opinion can not affect the ultimate success or failure of the work. Time will settle this question beyond the possibility of dispute.

I feel that it is due to the principal employees engaged on the work to state that during all the quarantine period, when they were practically deprived of their liberty and separated from their families and friends, not one of them deserted, but worked cheerfully and efficiently the long hours which I considered the emergency justified.

Very respectfully, your obedient servant,

H. S. Douglas,
Assistant Engineer.

Capt. Geo. McC. Derby,
Corps of Engineers, U. S. A.

Appendix 4 E.

REPORT OF MR. H. S. DOUGLAS, ASSISTANT ENGINEER, IN LOCAL CHARGE OF GOVERNMENT DEPOT, NEW ORLEANS, LA.

New Orleans, La., *May 1, 1898.*

Captain: I have the honor to submit the following report of operations at the Government depot, New Orleans, La., covering care, preservation, and repair of the plant belonging to the district for the period from May 1, 1897, to May 1, 1898.

At date of last report the plant consisted of 62 pieces. During the year 18 piec have been disposed of, as follows: Barges Nos. 11, 14, 230, 541, 544, 545, and 54 launches *Alaska* and *No. 5* and 4 side-dumping scows have been condemned an sold; barge No. 12 has been broken up and serviceable portions used for other pu poses, and barges A and C and No. 547 beached during high water.

The plant now on hand consists of 44 pieces, as follows: Standard gunwale barg Nos. 1 to 10, inclusive, and Nos. 15 to 27, inclusive; ordinary gunwale barges Nos. 54 546, 550, and B; warehouse, dock, pile driver No. 32; quarters boats *New Orlea* *Alpha, Beta, Gamma,* and *Delta;* tugs *Tilda* and *General Comstock;* steamers *Ru* and *Osceola;* hydraulic dredge *The Ram.* There are also 2 small lighters, 2 cam docks, side dock, pontoons, skiffs, etc.

REPAIRS.

Barge No. 6.—Entire new deck, new cypress deck beams, new head blocks, new rake plank, and 24 linear feet of new gunwale put in sides. Entire new set iron bitts put in. The deck beams were given a coat of N. O. preservative a covered on top with tarred paper. A pine deck of 1⅞ by 8 inch plank was th laid fore and aft and calked in the usual way, the seams being payed off with so pitch. This deck was then treated with the N. O. preservative. A covering of tarr paper as for a roof was then laid, and given a coat of roofing pitch. Over this t deck was sheathed with ⅞-inch tongued-and-grooved pine laid athwartships. As experiment the barge was painted with a "cold-water paint," but it does not seem be of much account. The cost of the repairs was $921.70.

Barge No. 7.—Entire new deck, new pine deck beams, 2 new streaks of head blo at one end, and 1 at the other, 3 new ends scarfed on gunwales, 3 new rake plan numerous graving pieces on sides, entire new set of iron bitts to replace wooden on A detailed description of deck is given in statement of repairs to barge No. 6. T deck, sides, and rakes were calked, and barge painted with iron-ore paint. Co $890.86.

Barge No. 8.—About 40 graving pieces put in gunwales, deck patched, 20 new timb heads put in, and 5 new rake plank on each end. Sides and rakes calked. Co $274.98.

Barge No. 9.—The worst of the old deck was cut out and 3,000 feet B. M. new dec ing put in, new covering board was put on, and 7 deck beams reenforced, 60 line feet of top gunwales were put in, and 5 graving pieces put in on sides, addition large wooden timber heads were put in, and 2 large iron bitts removed from bar No. 2 and placed on head block. Seven additional tie-rods were put in. The c deck, after being patched, was calked, covered with tarred paper, and sheathed t same as No. 6. Calking of sides and rakes was overhauled and barge painted wi iron-ore paint. Cost, $503.97.

Barge No. 16.—Entire new deck and deck beams. Side dock was placed und side and 5 new plank put in bottom. One new streak of head block was put on ea end and 8 graving pieces put in sides. Both rakes repaired and entire new set iron bitts put in. The sides and rakes were calked. The new deck is of the sa kind as that described as being put down on No. 6. Cost, $922.33.

Barge No. 17.—Entire new deck and deck beams, one new streak of head bloc 5 pieces rake plank put on one end and 4 on the other, 2 new ends scarfed on gu wales, entire new set of iron bitts put in. The sides and rakes were calked. (this barge creosote was used in place of N. O. preservative. The new deck w similar to that described on barge No. 6. The barge after completion of repairs w painted with iron-ore paint. Cost, $801.70.

Barge No. 24.—Gunwale repaired where broken by heavy drift. Six gravi pieces put in sides, covering board repaired, sides and rakes calked. Cost, $75.54.

Barge No. 28.—Two lower seams on sides and rakes calked. Cost, $8.25.

Barge No. 2.—Sides and rakes calked. Cost, $18.90.

Quarters boat Beta.—Camel dock was put under both ends, and sides and rak calked. Boat was painted inside and out. Cost, $55.

Tug Tilda.—Docked. One new sheet put in boiler and an entire new set of tub new breeching, new boiler casing, new ash pan, new furnace. New tail shaft a old wheel bushed and fitted to it. New crank pin and new forward end on cra shaft. Main cylinder bored and piston banded to suit, and fitted with new packi rings and follower. Main valve was planed and seat faced. Repairs were made guides, valve yoke, and stem. Four brass gibs were fitted to cross head. Bow w sheathed with No. 16 iron, cabin straightened up, deck beams overhauled, coal bunk enlarged and new roof put on cabin. Hull was calked and coal tarred to water li Shortly after these repairs were completed, and the boat let out of dock, the bush wheel became loose on the shaft. The tug was again docked and a new wheel fitt on the shaft.

The intermediate shaft was taken out, shortened, and fitted with new thrust rin The throttle valve was repaired and some slight work done on hull. Cost, $1,212.

Tug General Comstock.—Docked, and 12 new plank put in hull, new filling a

overing board on fantail, new stern chock, new deck from aft cabin to end of fan-
il, new stern chock, new deck from aft of cabin to end of fantail, new bumpers,
heave blocks, and grating. Coal bunkers repaired and two cavils refastened, bow
heathed with No. 16 iron, and hull and deck calked. Hull coal tarred to water line.
ew end on tail shaft, and new sectional stern bushing. One new thrust ring.
ain valve repaired and link overhauled. New piston rod for supply pump, and new
re-door liners. Furnace repaired. Cost, $751.16.

Steamer Ruby.—Docked and 12 new planks put in hull. New decking and nosing
rward and new deck aft in engine room. New cylinder timbers and new hog-
hain braces. New fillings for pitmans, and hull and deck calked. Four quarter
rasses for main journals, two pair wrist-pin brasses, two pair crosshead brasses,
our pair slide brasses. One new eccentric, four new link pins. Piston rods turned
nd fitted with new brass collars in stuffing boxes. Supply pump fitted with new
ide-valve stem pin and plunger, two gibs, and keys. Cost, $358.10.

The Ram.—*The Ram* was placed in the Good Intent Dry Dock and her sides and
ke at bow sheathed to water line with planking 3 inches thick. On account of
e rotten condition of the hull spikes would not hold, and the sheathing was
stened on with carriage bolts running through to the clamps on the inside of the
mbers. Rotten planks in the rake at the stern were taken out and replaced with
ew ones. After coming out of dock the dredge was returned to the depot and the
eathing of the hull completed. New fantails and nosing were put in, 400 feet new
ecking put down, new timbers placed forward for cutter frame and spur wheel,
tter frame repaired and strengthened with new timbers, new blocks for after sheer
gs and fair leaders made. A new rudder stock was made and wheel overhauled.
ylinder timbers were strengthened, seven new fenders made, and cabin repaired.
ew cutter head and bearing for cutter shaft were made, together with cast-iron
eaves, steel pins, brasses for capstan engine, etc. Cost, $1,969.73.

Ram's lighter.—This small barge was practically rebuilt at a cost of $276.68.

CURRENT REPAIRS.

Skiffs, side and camel docks, etc., have been kept in repair and minor repairs made
the plant generally. The cost of such work has been $339.50.

CARE OF PLANT.

Under this head I include supervision at the depot, pay of watchmen, pumping
arges, shifting fleet, putting out lines, sparring off, etc. The cost of this for the
ear has been $3,821.43.

I am glad to say that the general condition of the plant is excellent. The dredge
he Ram requires a new hull, which should be of steel; and some of the barges have
een repaired probably for the last time that economical repairs can be made.
arges Nos. 1, 2, and 3 are now over 14 years old and are yet serviceable. I
hink the statement can be safely made that, considering its age, there is no plant
n the Mississippi River that is in better or more serviceable condition than that
elonging to the Fourth district. As stated, the plant is old, and some of it should
e renewed at an early date. Should work be in progress at the same time at
atchez Harbor, Red and Atchafalaya rivers, and New Orleans Harbor, the present
lant is inadequate for the service, and at least seven new standard barges would be
ecessary to properly prosecute these works.

Very respectfully, your obedient servant,

H. S. Douglas,
Assistant Engineer.

Capt. Geo. McC. Derby,
Corps of Engineers, U. S. A.

Appendix 4 F.

EPORT OF MR. A. F. WOOLLEY, JR., ASSISTANT ENGINEER, IN LOCAL CHARGE OF IMPROVING ATCHAFALAYA AND RED RIVERS, LOUISIANA.

New Orleans, La., *May 1, 1898.*

Captain: I have the honor to submit the following report upon the work of
nproving Atchafalaya and Red rivers, Louisiana, under my local direction, for the
eriod from May 1, 1897, to May 1, 1898:

DREDGING OLD RIVER.

The conditions prevailing in Old River after the high water of 1897 were so
vorable to the exigencies of navigation, at the beginning of the usual dredging
eason, that it was apparent that but little dredging would suffice to maintain an

ample low-water channel, provided in the interim no serious sloughing of the ba occurred.

The season did afterwards prove to be a light one so far as dredging was c cerned, as will be seen from the tabulated statement of yardages removed from several localities.

The effect of the long-continued high stage of the Mississippi River, and the c sequent high velocity through Old River during a long period, was to sweep banks so clean, and in many cases to erode the slopes and undermine the banks such an extent, that serious sloughing was threatened.

Sloughing did begin in several localities and gave unmistakable evidence tha would be of such volume as to require the continuous service of *The Ram* fo period of three months or more to remove the combined yardages that would forced into the channel at the several localities, if nothing was done to relieve conditions tending to produce these sloughs.

A modification and comparatively practical prevention of this latter trouble w however, secured by prompt and thorough drainage of all lakes in the vicinity, b those immediately adjacent to Old River and those more or less remote from immediate banks of Old River; the latter, though not as menacing to the stability the banks, did offer some danger, and could be drained with economy compati with the threatened danger.

Dredging was necessary at the following localities: Carrs Point, Dead Tree, a Ash Cabin Light. Had the water continued longer at a low stage it would ha been necessary to dredge a channel about 400 feet long in front of Waverly Landi near Barbres light.

This condition, at a locality where no dredging has been required in several yea I attribute directly to the fact that the banks had been scoured to such an extent to form a more than normal width of low-water channel, having something like former depth clear across the section; or, in other words, an abnormal cross-secti area, and the lack of a velocity usually existing at that locality.

The conditions at the mouth of Old River (Carrs Point) were such as to requ the removal of about the usual number of cubic yards annually handled at t locality for each of the past several years. Notwithstanding the above, the la the land was such that I did obtain a more desirable channel than I have been a to procure heretofore, consistent with economy. The points of superiority of channel were ease and safety of navigation and its ability to resist decay under prevailing fluctuations in direction and velocity of current. The dredging at D Tree and Ash Cabin were both mainly due to a restriction of the channel wid caused by sides of channel being forced in by the sloughing banks; this strictu having a clay or mud bottom, resisted scouring in itself and deposited more or sand immediately above or below, with certain conditions of current.

The first season I was immediately in charge of dredging operations in Old Ri I prepared and submitted a sketch from survey of 1894 and 1895, showing River in contour, from top of bank to top of bank throughout its entire length; this sketch establishing what I determined should be the fixed channel limits future dredging operations, all of the details receiving your approval.

These fixed channel limits were determined with the following points in vi Economical maintenance, ease and safety of navigation, tendency to maintain original location from year to year as nearly as practicable, economy of first c struction, and location where a pilot would naturally look for a channel.

After a careful study of the situation, with each of the above qualifications view, it was considered entirely plausible to establish such fixed limits, with exception of the channel at the mouth of Old River (Garrs Point), which would h to be laid out each year to conform to conditions in that immediate vicinity, which are vastly changed by each successive flood of the Mississippi or of the River. After a period of several years' experience I am prepared to state that system is responsible for a saving of at least 50 per cent in the annual cost of f operations for these works, as compared with the former system.

I always find from year to year remains of channel dredged during previous yea and even though this channel might be obliterated in isolated spots, it is alway short and necessarily direct route to dredge through these obstructions and join disconnected ends.

The following tabulated statement will show the details of the work for the per of actual dredging operations, together with other data that might be of interes

Number of days (of ten hours) actual dredging	2
Number of days (of ten hours) delayed by breakdowns, minor repairs, shifting location of dredge, moving anchors, and raising lines for passing boats.	1
Sundays (no work)	
Total number of days (of ten hours) actually engaged in dredging operations	5

otal number of cubic yards handled	51,940
verage number of cubic yards handled per day, including delays	1,180
verage number of cubic yards handled per working day (of ten hours), actual dredging	1,737
ost per cubic yard of material handled during season, for period of actual dredging, including all expenses for time actually engaged, together with actual holidays and lost time from the usual causes during this period	$0.04173

umber of cubic yards handled at the localities where dredging was required, and the average handled per dredging hour for each.

Location.	Class of material.	Total.	Cost.	Average handled per hour.
		Cu. yds.		*Cu. yds.*
ars Point Bar	75 per cent sand and gravel; 25 per cent mud and clay.	32,190	$1,344	185
ead Tree	35 per cent clay and 65 per cent sand	8,060	336	155
sh Cabin light	30 per cent clay and 70 per cent sand	11,690	491	160

The period covered by dredging operations was 51 days—September 5 to October 5, inclusive—of which 7 were Sundays (no work), 8.1 were the usual stoppages and elays under ordinary working conditions, 6 were delays of an unusual character nder normal working conditions, such as repairing centrifugal pump, frequent hanges of location, the necessity of coaling without the aid of a tender, and 29.9 ays, or 299 hours, represent the time actively engaged in dredging.

It will be seen that a combination of circumstances permitted of 29.9 days' work nd a loss of 21.1 days out of the 51, or a loss of 41 per cent of the full time.

If we compute the price per cubic yard of material handled and to cover the full xpense of 51 days, 40 per cent of which is lost time, it would be $0.04173. Cost per ubic yard of material handled, to cover expense of all time, except stoppages of an nusual character, would be $0.031. Cost per cubic yard of material handled, to over expense of the actual dredging time, 29.9 days, would be $0.0244.

There was maintained in Old River throughout the season a navigable channel 7.5 o 10 or more feet below the zero of Barbre's gauge, except for short periods of from hree to five days, when there was not a greater depth than 5.5 feet at Dead Tree nd Ash Cabin.

The channel across Carrs Point was dredged to 8 feet below zero of Barbre's gauge, ith a bottom width of 100 to 110 feet.

The channels at Dead Tree and Ash Cabin Light were both dredged to a depth of .5 feet below zero of Barbre's gauge, with a bottom width of 100 feet.

ATCHAFALAYA SILL DAMS.

During the month of November, 1897, the usual annual surveys in the vicinity of he sill dams were made to determine the condition of these structures. Seven ongitudinal sections through each of the dams and cross sections (even numbers nly) 4 to 52 of original surveys, were sounded for comparison with former surveys.

These surveys were made with the greatest possible care to determine, as accuately as possible, the nature and extent of such changes as might have been ccasioned by recent unprecedented high water, and with a view to throwing all he possible light on the question of the probable advisability of strengthening or rotecting these structures during the coming season.

All soundings less than 25 feet were taken with a pole, and those of a greater epth were taken with the ordinary lead and line in the hands of a good leadsman.

It might here be noted that the soundings taken with a pole embrace the greater art of the area covered by Dam No. 1 and a large portion of area covered by Dam o. 3, as well also as the immediate shore portion of the territory embraced by the urveys. I have prepared and submit herewith cross sections in vicinity of Sill ams 38 to 48, inclusive, longitudinal sections through Sill Dam No. 3, longitudinal ection (profile) through channel of Atchafalaya in the vicinity of sill dams. Shore evels were run over such sections as gave evidence of recent changes. These were ractically altogether on the right bank, and the greatest changes are embraced by evels platted on sections 38 to 48, though there are material changes in the shore ortions of other sections between the dams; but these latter will not be considered o much in detail as the former.

In the sketches submitted, surveys of 1894 (in black) are only compared with survey f 1897 (in red). My reason for this is to compare the present condition of these tructures and the surrounding vicinity directly with the most serious condition hat has been evidenced by any former surveys—namely, 1894.

The survey of 1896 actually showed what I considered to be an unpreceden deposit in the Atchafalaya from the head to a certain distance below the dams, far as I had occasion to examine, and I can find no record of silting in such volu previous to that date.

In my report of February 19, 1897, I made mention of this unusual depo advanced my reasons for it, and stated why in my opinion all evidences of t deposit would practically be swept away by the next high water sufficient to p duce a strong current in the Atchafalaya, and generally speaking, from a care scrutiny of the surveys of 1897, I believe it will be conceded that this has pro largely true.

Comparing surveys of 1894 and 1897, sections 38 to 50, inclusive, it may be no that the extreme depth of sections 48 and 50 are the only ones which have materia increased since 1894, and that the remainder of the above-enumerated sections (38 46, inclusive) had less depth and flatter slopes in 1897 than existed on these seve sections in 1894.

It is to be seen, however, for 1897 that, notwithstanding the flatter slopes and less depths than those which existed in 1894, with exceptions already noted abo there had been a recent movement of the shore portion of these sections. This, my mind, would seem to indicate that there must have existed (as cause for t movement), say immediately after the high water of 1897, as great or greater dept as steep or steeper slopes than those which existed at the date of 1894 surveys, which latter time the banks and slopes had reached and did maintain an equilibri until some date subsequent to the flood of 1897.

The fact that there were flatter slopes in 1897 than in 1894, on the right bank these sections, is in a number of instances beyond question due to the fact that la volumes of material above water surface had very recently subsided, sloughed caved into the water, following the slope down to or nearly down to the toe of subaqueous portion of the slope. It, indeed, is a question in my mind whether decrease in depth in 1897 as compared with that of 1894, for sections below Dam 3, is not, at least to a large extent, due to this recent movement of the bank, wh was mainly of a sloughing nature, and in such masses as to slide with great moment on a comparatively flat slope after once being set in motion.

I will now consider the longitudinal sections through Dam No. 3.

Subsection 9 through crest of dam is compared, 1894 with 1897, 1895 with 18 and 1896 with 1897. In 1894 at the time surveys were made I could not get hol an experienced leadsman, and while the only man available at the time was car and painstaking, I rely less on the results than I do on those of 1895, 1896, and 18 Soundings in 1895 were taken with a lead line in the hands of a careful and exp enced leadsman, whose work is as reliable as work by this method can be. soundings in 1896 and 1897 were taken with a rod to 25 feet of depth, and grea depths were taken with lead and line in the hands of a competent leadsman. I the fore attach the most and equal importance to results of surveys of 1896 and 189 slight bit less to those of 1895 for depths less than 25 feet, and the least importa to the entire subaqueous portion of surveys of 1894.

From a glance at the comparison between 1894 and 1897 it may be seen that th is a less difference between the two than there is between 1895 and 1897 or 1896 1897, which is the reverse of the theory that the structure is deteriorating. Thi in a large measure, due to lack of an experienced leadsman. It will be noted, comparisons of section 9, from surveys of 1895, 1896, and 1897, that the main w defined channel across the dam near the right bank showed something like a grad decline in elevation through each year to and including 1897, and it may also observed that this apparent tendency of the crest to sag is rather pronounced in shoreward movement toward the right bank, the bank which showed at date 1897 survey marked signs of recent movement.

The right bank, throughout the entire vicinity of these structures, showed sures above the low-water line, these being continuous for a distance of 400 to feet at points, and very marked in several instances where they stand open as m as 2 feet at the top and where there had at that time been no pronounced movem in the adjacent bank.

I have to call attention to the fact that one of these fissures existed in the lo two-thirds of the right bank superaqueous portion of Sill Dam No. 3, the grea opening being not less than 18 inches wide and 5 feet deep. These openings expo to plain view stringers and other timbers in the frames of the sill, a number which have been constantly covered by deposit; these were severed though ma were still comparatively sound; yet they gave way to some subaqueous force forces, there being no other causes above water, as the slope above is comparati flat, paved with mattresses and stone, is in a restricted width of river and on bend side, all of which tend to reduce to a minimum any tendency to a deposi weighting of this immediate slope.

The sections between the dams have shown a maximum increase of 4 feet over t

1894 and 19 feet over that of 1896. There was immediately previous to the sur- of 1897 extensive caving of the banks of the Atchafalaya below and remote n the dams; there was at the same date a pronounced settling of the right bank re at points above and distant from the dams in a vicinity which has shown no rked signs of this kind for the past four years. Each successive higher water es a current which increases in velocity in a greater ratio than that in the Mis- ippi, each succeeding higher water is accompanied by a greater scouring or ero- power and consequently a greater menace to any structure which might be ired by great velocities.

he past high water produced a current of such velocity that it became impracti- le or unsafe to operate towboats in the Atchafalaya for a time. We have seen power of the last high water to remove a previous heavy deposit, and in places nake new encroachments on either bottom, bank, or area of section.

'e must prepare or expect at some future date to hold these dams under the ages of a current velocity as great or greater than that of 1897.

Very respectfully, your obedient servant,

A. F. WOOLLEY, Jr., *Assistant Engineer.*

apt. GEO. McC. DERBY,
Corps of Engineers, U. S. A.

APPENDIX 4 G.

ORT OF ASSISTANT ENGINEER W. J. HARDEE, IN LOCAL CHARGE OF THE LOWER ENSAS, ATCHAFALAYA, LAFOURCHE, BARATARIA, PONTCHARTRAIN, AND LAKE ORGNE LEVEE DISTRICTS.

NEW ORLEANS, LA., *May 1, 1898.*

EAR SIR: I have the honor to submit the following report for the works under local direction for the year ending May 1, 1898:

GENERAL METHODS.

onstruction.—As soon as the flood of 1897 subsided work was promptly resumed ll levees where operations had been suspended.

he first of the levee work to be done under the 1898 allotments was advertised ngust.

arly in September yellow fever was declared epidemic at New Orleans and eral towns in the State of Mississippi. Quarantines were instituted, and in a few s every avenue of travel was blocked; indeed, so tightly were the lines drawn t it was not possible to cross the river from one parish to another, or even go n one place to another in the same parish. This state of affairs continued until latter part of November.

s a result of the quarantine many contractors were unable to promptly reach ir works, while others who had been fortunate enough to do so suffered much incon- ience and loss of time by reason of their inability to transport men and supplies. yellow fever not only caused a loss of several months of the most profitable e of the year for levee building at the works under contract, but delayed levee k in general for a corresponding period. Quarantines prevented advertising and ting the balance of the allotments under contract early in the fall.

uring the month of March the river rose to a height sufficient to flood the borrow and generally interrupt work in progress. At the date of this report a large unt of work to be paid for from the 1898 allotments remains to be done.

tabulated statement for each district is herewith submitted and furnishes ailed information for all levees built and constructing.

fuck or base ditches.—The practice of cutting a muck or base ditch was continued places where the existing embankment was known to be leaky. Leaks are usually to holes or cavities made through or under the embankment by burrowing ani- ls, or partly decayed logs or other vegetation not removed from the surface of the und or just beneath it, or surreptitiously placed in the body of the levee at the e of its construction.

epairs.—During the months of July, August, and September, 1897, all United tes levees were repaired and put in good condition. Repairs consisted of cutting removal of weeds and other objectionable vegetation, restoration of rain and ve wash, resodding where grass had failed to grow, and restoring impaired drain- of borrow pits.

upervision.—Up to January, 1898, the same system of supervision as reported for past several years prevailed. Since January I have had general supervision of all levee work in the Fourth Mississippi River district; Mr. L. E. Lion has had supervision of the Lower Tensas district; Mr. W. E. Knobloch has had local s vision of the Atchafalaya district; Mr. J. W. Monget has had local supervision o Lafourche district and the Pontchartrain district; Mr. H. B. Watson had local s vision of the Barataria district and the Lake Borgne district up to April 1, wh was succeeded by Mr. John Klorer.

These men represent this office in the management of protection work during water. Throughout the year they see that the levee line is kept in thorough re draining borrow pits and replacing wave wash after each high water, and kee weeds cut down at all seasons; they make all surveys necessary for proposed w they supervise the work of contractors and inspectors; do all instrumental necessary to the proper execution of contracts and certify to their satisfactory pletion; they make recommendations as to the efficiency of the levee line of district which intimate contact with the work brings to mind; they are requ to carefully inspect every foot of their line once a month and oftener if practic in addition to such special reports as circumstances from time to time demand are required to submit monthly reports specifying the extent and dates of inspections, what surveys or special examinations have been made, the general dition of the levee line, character and progress of repair work, the date of mencement and completion of contracts under way, and the percentage of emb ment in place at each.

A number of inspectors were employed at $90 and $75 per month and statione levees during the time of their construction. It is the duty of these men to re upon the levee at all times during working hours, see that the specification complied with, keep a daily record of force and operations, and submit we reports of same.

Inspection.—Use of the bicycle for levee inspection, which was largely ex mental last year, has been successfully demonstrated; nearly all of the inspe have them, and their use is attended with much profit, both as to time and co transportation.

Preservation of works.—Under authority of your project of July 9, 1897, appr July 21, 1897, twenty-four of the proposed twenty-six foundations for the depo warehouses, in which to store high-water tools and materials, have been built i Lower Tensas district, and seven of the proposed twenty-six foundations in Atchafalaya district have been built; as yet none have been built in the othe tricts. These foundations consist of a "bench" of earth, having a surface mea ment of 64 by 32 feet, with the steepest side slopes the building material will per they adjoin the levee at equal grade, and are built on the land or river side, as conditions suggest as most expedient.

It has been decided to give the warehouses some characteristic style of arch ture, and a castle, emblematic of the engineer corps, has been practically decide

For purposes of experiment one house has been built at Kempe Levee (658 R) one at Gibsons Landing Levee (683 R), in the Lower Tensas district; these h have been built on the same general lines, with slight differences of detail. A house will shortly be built, with some further modifications. It is then exp that a final plan will be adopted and the remainder of the houses built.

LOWER TENSAS LEVEE DISTRICT.

It was intended that a new levee should be built at Ashley (724 R) to provid a threatened breach of the existing line, but the bidder to whom the work awarded defaulted. Quarantine complications prevented readvertisement of work earlier than November 15. The proposed levee is about 2¼ miles long and tains about 315,000 cubic yards. As it was apparent that such a large work c not be undertaken at so late a date and completed by usual high-water time (M no further effort was made to put it under contract. Caving has continued a locality and it now seems certain that the proposed levee must be built durin coming season in order to assure continuity of line for next year's flood.

A new levee 8,314 feet long and containing 372,874 cubic yards is building b United States at L'Argent (665 R) to cover a threatened breach of the exi levee. This work should have been completed by March 1, but owing to d occasioned by quarantines and very bad weather during the months of Decem January, and February it is only 42 per cent completed at the date of this rep

A new levee 1,526 feet long, containing 44,910 cubic yards, was built by the U States at Glasscock (725 R) to restore the embankment destroyed by the Glass crevasse. The new levee was built on the original line.

Quarantine complications caused this work to be put under contract late i fall. While the January rise in the river did not overtop the bank it was suffi to destroy all natural drainage. As the contractor had the work well adva and was in no wise delinquent, the United States established a pumping out levee to keep the borrow pits drained that construction might proceed without rruption. The pump was operated for about three weeks and discontinued t as soon as the river fell and natural drainage was restored.

new levee 1,052 feet long and containing 8,718 cubic yards was built by the ted States at Fairview (728 R) to provide for a threatened breach of the existing ee.

he Fifth district levee board built a new levee 5,118 linear feet long and contain- 171,037 cubic yards at Bedford (606 R) to cover a breach in the levee line made caving bank. The same board is building a new levee 1,213 feet long and con- ing 27,500 cubic yards at Claggett (644 R). This work is about 30 per cent com- ted at the date of this report.

ll work done by the United States in this district, other than the new levees rred to at L'Argent, Glasscock, and Fairview, has been enlargement of existing ee; contracts which were interrupted by the flood of 1897 were continued and all e completed by May 1, 1898, except Rifle Point (689 R) and Ashley to Fairview R).

nder the 1898 allotment 37,046 linear feet of levee enlargement, containing 677 cubic yards, was contracted for. Some of this work suffered slight interrup- from the January rise. The April rise flooded the foreshores and stopped all k. Operations have not been resumed at the date of this report. Of the length cubic yards contracted for, 29,770 linear feet and 526,992 cubic yards have been pleted.

onstruction of new levee by the United States at Fairview (728 R) occasioned the ndonment of 1,325 linear feet of embankment, containing, approximately, 9,900 ic yards.

f the 677,019 linear feet, or 128.13 miles, of effective levee on May 1, 1898, there are 967 linear feet, or 85.2 miles, built wholly or in part and paid for by the United tes.

ATCHAFALAYA LEVEE DISTRICT.

ll of the work done during the year by the United States consisted of enlarge- t of existing embankment. The district levee board built lines of new levee at key (841 R), Plaquemine (854 R), Eimer (865 R), Hanlon (867 R), Smoke Bend R), St. Francis Church (885 R), and at Port Barrow (886 R), containing 467,403 ic yards and 12,213 linear feet of new line.

f the 50,765 linear feet and 745,940.99 cubic yards contracted for under the 1898 tment, 16,936 linear feet and 242,655.58 cubic yards are completed at this date, 1, 1898.

f the 676,000 linear feet, or 128.03 miles, of effective levee on May 1, 1898, there 440,843 linear feet, or 83.49 miles, built wholly or in part and paid for by the ted States.

LAFOURCHE LEVEE DISTRICT.

ll of the work done during the year by the United States was raising and arging existing embankments. Of the 29,527 linear feet and 258,442.06 cubic yards tracted for under the 1898 allotment, 5,700 linear feet and 29,691.09 cubic yards completed at this date, May 1, 1898. The district levee board built lines of new e at Pikes Peak (905 R) and Davis (902 R), aggregating 7,272 linear feet and taining 234,652 cubic yards.

f the 433,278 linear feet, or 82.06 miles, of effective levee on May 1, 1898, there 264,138 linear feet, or 50.03 miles, built wholly or in part and paid for by the ted States.

PONTCHARTRAIN LEVEE DISTRICT.

he United States built a new levee at Conrad (839 L) to restore the gap made in line by the crevasse which occurred during the flood of 1897. This line is 1,728 ar feet long and contains 38,680.46 cubic yards.

he district levee board is building a new levee 3,197 linear feet long and con- ing, approximately, 112,000 cubic yards, at Margaret (863 L), to provide for a eatened breach of the existing levee.

ll the work done by the United States in this district other than the new levee Conrad was raising and enlarging existing embankments. Of the 78,075 linear and 835,912.83 cubic yards contracted for under the 1898 allotment, 35,626 linear and 384,702.71 cubic yards are completed at this date, May 1, 1898.

f the 662,701 linear feet, or 125.51 miles, of effective levee on May 1, 1898, 494,471 ar feet, or 93.65 miles, have been built wholly or in part and paid for by the ted States.

BARATARIA LEVEE DISTRICT.

The United States is building a new levee 7,663 linear feet long and cont
67,323 cubic yards from Ballay to Orange Farm (1023 R). On account of
occasioned by quarantine and high stages of river in January and March, onl
linear feet and 62,000 cubic yards are completed at this date, May 1, 1898.

All other work undertaken by the United States is raising and enlarging e
embankment. Of the 47,457 linear feet and 201,338 cubic yards contracted for
the 1898 allotment, 23,220 linear feet and 109,786 cubic yards are completed
date, May 1, 1898.

Of the 371,998 linear feet, or 70.45 miles, of effective levee on May 1, 1898,
linear feet, or 34.95 miles, have been built wholly or in part and paid for
United States.

LAKE BORGNE LEVEE DISTRICT.

All work contracted for under the 1898 allotment is raising and enlarging e
embankment. Of the 46,787 linear feet and 187,136 cubic yards put under co
34,547 linear feet and 136,065 cubic yards are completed at this date, May 1, 1

Of the 253,426 linear feet, or 48 miles, of effective levee on May 1, 1898,
linear feet, or 31.34 miles, have been built wholly or in part and paid for
United States.

HIGH-WATER PROTECTION.

Although a high stage of water was experienced at certain points in the d
nothing like a dangerous flood had to be contended with.

The following table of comparative gauge readings is submitted and se
show the maximum height attained this year and in 1897; also the highest r
recorded prior to 1897:

Gauges.	1897.	Previous record.
	Feet.	*Feet.*
Vicksburg	52.3	49.05
Natchez	49.8	48.60
Red River Landing	50.2	48.87
Bayou Sara	43.7	42.25
Baton Rouge	40.6	38.45
Plaquemine	36.2	33.75
Donaldsonville	32.8	30.60
College Point	27.8	25.90
Carrollton	19	17.45
Fort Jackson	7.2	6.9

It will be noted that, last year excepted, the river reached a higher stage at
burg than ever before, making the largest wave that has ever been carried
Gulf without a crevasse. Owing to the low stage of Red River the gauges
south of Natchez were not relatively as high as at Vicksburg.

The entire line of levee of the fourth district was under a fair strain, but fortu
the high stage was of short duration and no emergency work was anywhere req

Owing to the general inaccessibility of the Lower Tensas district, and its di
from a base of supplies, preparations were made for a high-water campaign
the river reached its maximum at Cairo. Lumber and tools were placed at th
posed depot or warehouse sites, at intervals of 5 miles, and put in charge of
men. Additionally, the district was divided into beats of 15 miles, and an ins
placed on each beat to daily patrol and inspect the line. He was required t
fully posted as to the condition of every foot of his line and as soon as a we
would develop to promptly call the attention of the district levee commissione

A similar patrol, with same length beats, was maintained in the Pontch
district.

Very respectfully, your obedient servant,

W. J. Hardee, *Assistant Engi*

Capt. Geo. McC. Derby,
Corps of Engineers, U. S. A.

APPENDIX 4 H.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., August 11, 1897.

-Abstract of proposals received in response to advertisement dated August 2, 1897, d this day by Capt. George McC. Derby, Corps of Engineers, for levee work in the h district, improving Mississippi River.

L'ARGENT TO GIBSONS.

Name and address of bidder.	Section 1.	Section 2.	Section 3.	Section 4.	Section 5.	Section 6.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
P. White, New Orleans, La	18	18	18	18	18	18
A. Helgason, Ashwood, La	13.95	13.95	13.95	13.95	13.95	13.95
D. Leeper, St. Joseph, La	16	16	16	16	16	16
. Bobbitt, Hard Times, La	15.50	15.50	15.50	15.50	15.50	15.50
P. Martin, Waterproof, La	14	14	13.75	13.75	14	14
bish & O'Neil, St. Joseph, La	a12.45	a13.50	a12.45	a12.45	a12.45	a12.45

Name and address of bidder.	Section 7.	Section 8.	Section 9.	Section 10.	Section 11.	Section 12.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
ipple & Gammill, Plaquemine, La	16.50	16.50	16.50	16.50	16.50	16.50
A. Helgason, Ashwood, La	a13.95	a13.95	a13.95	a13.95	a13.95	a13.95
D. Leeper, St. Joseph, La	16	16	16	16	16	16
P. Martin, Waterproof, La	15	15	15	15	15	15
bish & O'Neil, St. Joseph, La	14	14	14	14	14	14

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., August 21, 1897.

-Abstract of proposals received in response to advertisement dated August 11, 1897, l this day by Capt. George McC. Derby, Corps of Engineers, for levee work in Fourth t, improving Mississippi River.

Name and address of bidder.	Pontchartrain district.				
	Section 1.	Section 2.	Section 3.	Section 4.	Section 5.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
vner & Kilkenny, Shreveport, La	14.70	14.70	14.25	14.25	14.75
s. Whelan, St. Louis, Mo	27	27	27	27	27
Hanick, St. Louis, Mo	26	26	26	26	26
. Bobbitt, Hard Times, La	16.50	16.50	16.50	16.50	16.50
. Moody, New Orleans, La	16.70	16.70	16.70	16.70	16.70
. White, New Orleans, La	16	16	16	16	16
. Byrne, Plaquemine, La	16.50	16.50	16.50	16.50	16.50
rin & O'Connor, Union, La	a14.50	a14.50	a13.50	a13	a13
es Carroll, St. Louis, Mo	27	27	27	27	27

Name and address of bidder.	Pontchartrain district.			
	Section 6.	Section 7.	Section 8.	Section 9.
	Cents.	*Cents.*	*Cents.*	*Cents.*
vner & Kilkenny, Shreveport, La	....	....	....	....
s. Whelan, St. Louis, Mo	27	27	27	27
Hanick, St. Louis, Mo	26	26	26	26
. Bobbitt, Hard Times, La	a17	a17	a17	a17
. Moody, New Orleans, La	18	18	18	18
. White, New Orleans, La	16	16	16	16
. Byrne, Plaquemine, La	....	....	....	....
rin & O'Connor, Union, La	....	....	....	....
es Carroll, St. Louis, Mo	27	27	27	27

a Accepted; bid No. 6 was for all or none.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., September 7, 18

No. 8.—*Abstract of proposals received in response to advertisement dated August 17, opened this day by Capt. George McC. Derby, Corps of Engineers, for levee work in F district, improving Mississippi River.*

No.	Name and address of bidder.	Esper Lev sectio and
		Cen
1	C. D. Leeper & Co., New Orleans, La	
2	Charles O'Donnell & Co., Hard Times, La	*a*

a Accepted; prices bid are per cubic yard.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., September 7, 18

No. 9.—*Abstract of proposals received in response to advertisement dated August 17, opened this day by Capt. George McC. Derby, Corps of Engineers, for levee work in F district, improving Mississippi River.*

No.	Name and address of bidder.	Fair Lev secti
		Ce
1	Charles O'Donnell & Co., Hard Times, La	
2	M. A. Wogan, New Orleans, La	
3	W. A. Miller, Fairview, La	
4	D. P. Lyles, Cross, La	*a*
5	C. D. Leeper & Co., New Orleans, La	
6	Rutherford & Dalgarn, Natchez, Miss	

a Accepted; prices bid are per cubic yard.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., December 21, 1

No. 10.—*Abstract of proposals received in response to advertisement dated Decem 1897, opened this day by Capt. George McC. Derby, Corps of Engineers, for levee w Fourth district, improving Mississippi River.*

No.	Name and address of bidder.	St. Claude Levee.	Nina Levee.			
			Sections 1 and 2.	Sections 3 and 4.	Sections 5 and 6.	Se 7
		Cents.	*Cents.*	*Cents.*	*Cents.*	*C*
4	F. M. McLaughlin, Waterproof, La	*a* 16.25	*a* 16.25	*a* 16.25	*a* 16.25	
9	Hearin & O'Connor, Baton Rouge, La	16.50	16.50	16.50	16.50	
11	C. E. Ponder, Shreveport, La	19.90	19.90	19.90	19.90	
13	Batt O'Brien, Morville, La	16.48	24.74	24.74	24.74	
14	Clark & Reagan, Red River Landing, La	16.70	16.70	16.70	16.70	
15	J. R. Serpell & Co., Louisville, Ky	16.75	18.20	18.20	18.20	

No.	Name and address of bidder.	Belle Vale Levee, sections 1 and 2.	Viola Levee.		
			Sections 1 and 2.	Section 3.	Se 4
		Cents.	*Cents.*	*Cents.*	*C*
1	M. L. Linan, Point Coupee, La	....	14.98	14.98	
3	W. J. Bentley & Co., New Orleans, La	15.50	15.50	15.50	
4	F. M. McLaughlin, Waterproof, La	15.00	15.00	15.00	
7	I. R. Bobbitt, Baton Rouge, La	*a* 12.50	*a* 12.50	*a* 12.50	
8	O. E. Gammill, Bayou Sara, La	15.98	14.98	14.98	
9	Hearin & O'Connor, Baton Rouge, La	15.20	14.20	14.20	
11	C. E. Ponder, Shreveport, La	14.48	14.48	14.48	
13	Batt O'Brien, Morville, La	16.74	16.49	16.49	
15	J. R. Serpell & Co., Louisville, Ky	17.00	17.00	17.00	

a Accepted; prices bid are per cubic yard.

o. 10.—*Abstract of proposals received in response to advertisement dated December 8, 1897, opened this day by Capt. George McC. Derby*—Continued.

o.	Name and address of bidder.	Pontchartrain District.				
		Section 10.	Sections 11 and 12.	Sections 13 and 14.	Sections 41 to 50.	Sections 97 to 103.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
2	R. M. Quigley & Co., St. Louis, Mo	23	23	23	23	23
6	M. Hanick, Manchac, La	*a*18	*a*18	*a*14.49	*a*12.90	*a*14.49
7	I. R. Bobbitt, Baton Louge, La	13.50	13.50	13.50	....	....
4	Clark & Reagan, Red River Landing, La	18.23	18.23	18.23	18.23	18.23

a Accepted; prices bid are per cubic yard.

The above bids were for all or none of the whole line.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., January 31, 1898.

o. 11.—*Abstract of proposals received in response to advertisement dated December 27, 1897, opened this day by Capt. George McC. Derby, Corps of Engineers, for furnishing a steel tow-boat for use in Fourth district, Mississippi River improvement.*

o.	Name and address of bidder.	Price bid.
1	Marietta Boiler Works, Marietta, Ohio	$27,000
2	Iowa Iron Works, Dubuque, Iowa	*a*27,750
3	Schultz Bridge and Iron Co., Pittsburg, Pa	30,000

a Accepted; bid No. 1 was unsatisfactory.

APPENDIX 4 I.

List of contracts in force, Fourth district, improving Mississippi River, with names of contractors, dates of approval of contracts, dates of beginning work, expiration of time for completion, and extensions granted.

No.	Name of levee.	Below Cairo.		Contractor.	Date of approval.	Date of beginning work.	Date of expiration of contract.	Extension of time granted.
		Miles.	Bank.					
1	L'Argent	665	R.	John Scott & Sons	Nov. 22, 1897	Oct. 8, 1897	Mar. 1, 1898	June 1, 1898
2	Delhi	680	R.	Helgason Bros	Dec. 9, 1897	do	May 31, 1898	
3	Rifle Point	689	R.	Manning & Gibson	Nov. 19, 1896	Oct. 16, 1896	Feb. 15, 1897	Do.
4	Esperanza	715	R.	Chas. O'Donnell & Co	Dec. 29, 1897	Oct. 8, 1897	Mar. 1, 1898	
5	Red River Landing	766	R.	Edward P. White	May 23, 1896	May 12, 1896	Sept. 30, 1867	Mar. 1 1898
	Smithland	770	R.		do	do	do	
	Raccourci	785	R.		do	do	do	
	Raccourci to Longwood	786	R.		do	do	do	
	New Texas	786	R.		do	do	do	
	Poche to Morganza	787	R.		do	do	do	
6	Fleta	786	R.	do	Oct. 9, 1897	Sept. 20, 1897	Mar. 1, 1898	
7	Morrison	793	R.	Geo. Y. Andrews	Nov. 29, 1897	do	do	
	Point Coupee	796	R.		do	do	do	
8	St. Claude	805	R.	F. McLaughlin	Feb. 11, 1898	Jan. 15, 1898	Jan. 1, 1898	
	Nina	806	R.		do	do	do	
9	Highland	815	R.	I. R. Bobbitt	Nov. 2, 1897	Sept. 20, 1897	Mar. 1, 1898	
10	Belle Vale	826	R.	do	Mar. 4, 1898	Jan. 15, 1898	Jan. 1, 1898	
	Viola	828	R.		do	do	do	
11	Ballay to Orange Farm, sections 1 to 4	1,022	R.	Victor Adema	Nov. 17, 1897	Sept. 27, 1897	Feb. 1, 1898	
12	Ballay to Orange Farm, sections 5 to 7	1,024	R.	W. J. Bentley & Co	Oct. 19, 1897	do	do	Sept. 1, 1898
13	Sections 6 to 9, inclusive (Pontchartrain district)	836	L.	I. R. Bobbitt	Sept. 16, 1897	Sept. 1, 1897	Mar. 1, 1898	
14	Sections 15 to 20, inclusive, and 22 to 40, inclusive (Pontchartrain district).	843	L.	Michael Hanick	Sept. 22, 1897	do	do	Apr. 10, 1898
15	Sections 10 to 14, inclusive, 41 to 50, inclusive, and 97 to 103, inclusive (Pontchartrain district).	850	L.	do	Jan. 31, 1898	Jan. 15, 1898	Jan. 1, 1899	
16	Story to Caernarvon	976	L.	W. F. Barbour & Son	Oct. 21, 1897	Sept. 27, 1897	Feb. 1, 1898	Apr. 1, 1898
17	One steel towboat			The Iowa Iron Works, Limited, E. M. Dickey, president, Dubuque, Iowa.	Mar. 29, 1898	Mar. 20, 1898	Aug. 4, 1898	

NOTE.

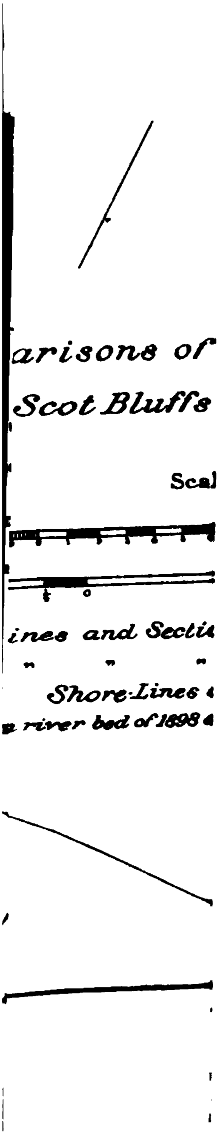
[To follow page 3458 of the Annual Report of the Chief of Engineers for 1898.]

Plate No. 4 is printed in the text on pages 3308 and 3309.

Plates Nos. 21, 22, 23, 25, 27, and 29 are printed in the text on pages 27 to 3335.

Plates Nos. 89, 90, and 91 are printed in the text on pages 3337 to 40.

Plate No 92 is printed in the text on pages 3342 and 3343.



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4	Esperanza	715	R.	Chas. O'Donnell & Co	Dec. 29, 1897	Oct. 8, 1897	Mar. 1, 1898	
5	Red River Landing	766	R.	Edward P. White	May 23, 1896	May 12, 1896	Sept. 30, 1867	Mar. 1 1898
	Smithland	770	R.		do	do	do	
	Raccourci	785	R.		do	do	do	
	Raccourci to Longwood	786	R.		do	do	do	
	New Texas	786	R.		do	do	do	
	Poche to Morganza	787	R.		do	do	do	
6	Fleta	786	R.	do	Oct. 9, 1897	Sept. 20, 1897	Mar. 1, 1898	
7	Morrison	793	R.	Geo. Y. Andrews	Nov. 29, 1897	do	do	
	Point Coupee	796	R.		do	do	do	
8	St. Claude	805	R.	F. McLaughlin	Feb. 11, 1898	Jan. 15, 1898	Jan. 1, 1898	
	Nina	806	R.		do	do	do	
9	Highland	815	R.	I. R. Bobbitt	Nov. 2, 1897	Sept. 20, 1807	Mar. 1, 1898	
10	Belle Vale	826	R.	do	Mar. 4, 1898	Jan. 15, 1898	Jan. 1, 1898	
	Viola	828	R.		do	do	do	
11	Ballay to Orange Farm, sections 1 to 4	1,022	R.	Victor Adema	Nov. 17, 1897	Sept. 27, 1897	Feb. 1, 1898	
12	Ballay to Orange Farm, sections 5 to 7	1,024	R.	W. J. Bentley & Co	Oct. 19, 1897	do	do	Sept. 1, 1898
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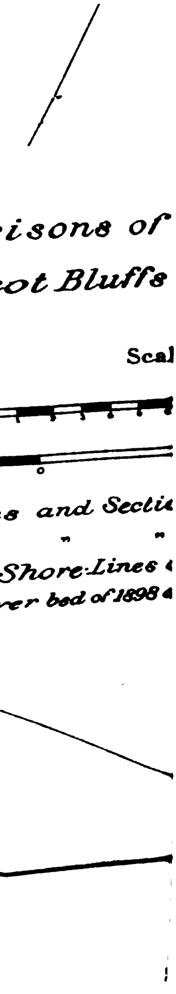

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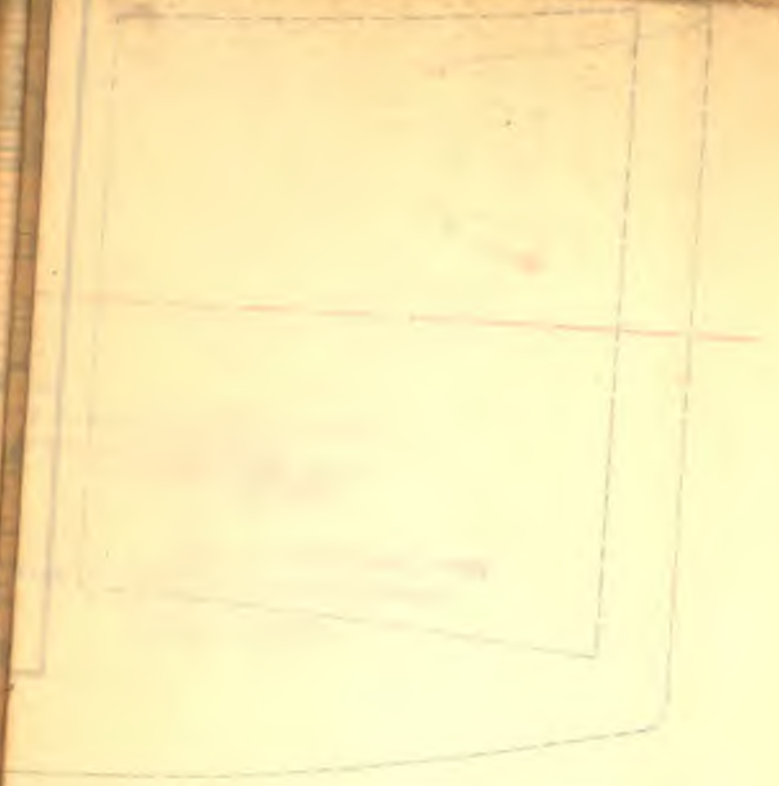

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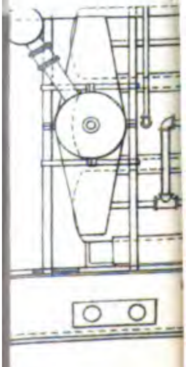

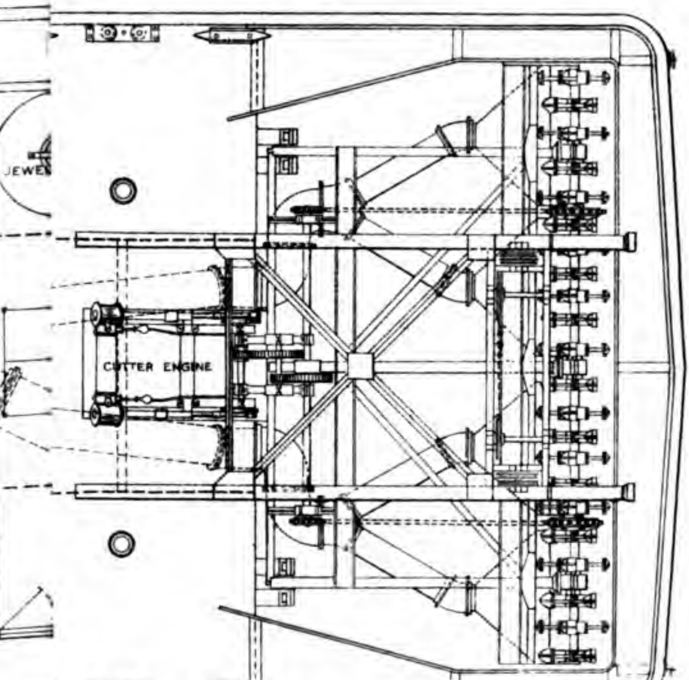

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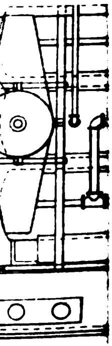

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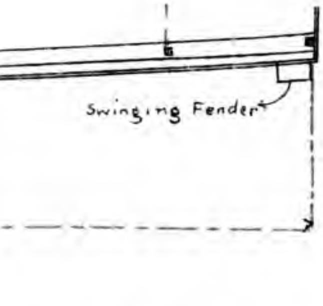
Swinging Fender

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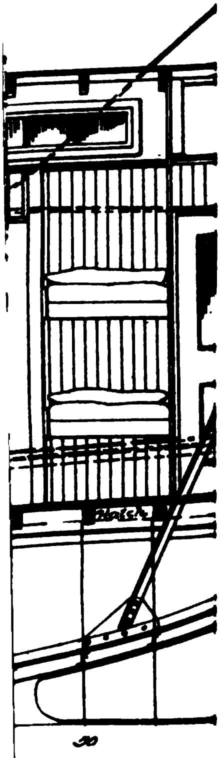
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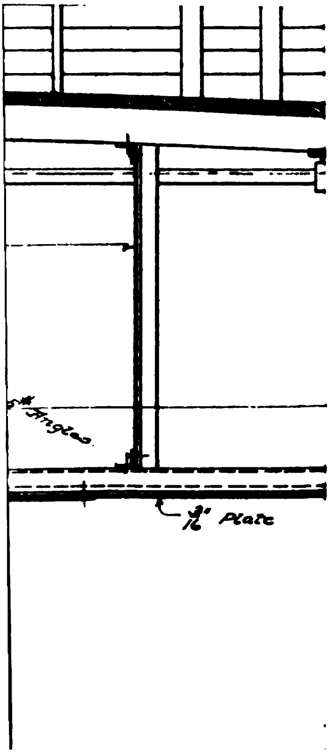
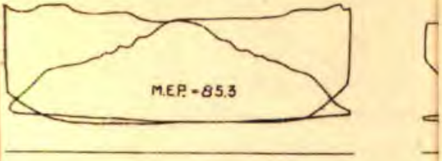

5# Angles
3/16" Plate

Test No. 5

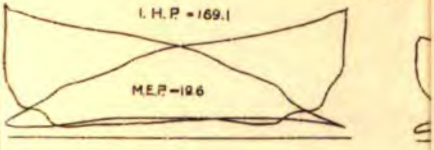
DELIVERY HEAD - 34.7 FT.

I. H. P. - 278.8



STEAM PRES. - 155
REV. - 181

I. H. P. - 169.1



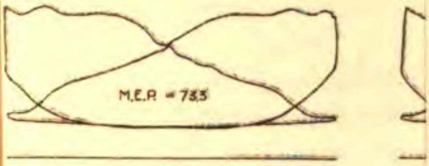
I. H. P. ON PORT CRANK - 447.9　　I H

TOTAL I. H. P. - 712.4

Test No. 6.

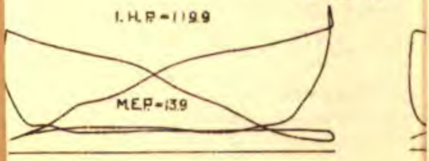
PUMP VAC. - 17.0 FT OF
DELIVERY HEAD - 37.7 FT OF

I. H. P. - 239.6



STEAM PRES. - 160
REV. - 181

I. H. P. - 119.9



I. H. P. ON PORT CRANK - 359.5　　I. H. P

TOTAL I. H. P. - 738.3

10.

ZETA.

PLATE NO. 28

To accompany Annual Report of Mississippi River Commission for 1898.

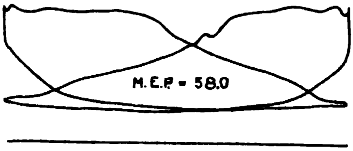
H. E. Waterman

Captain, Corps of Engineers, U. S. A.,
Secretary.

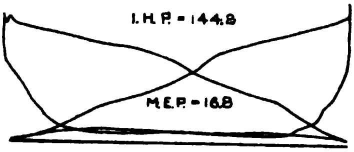
TEST No. 5.

PUMP VAC. = 11.3 FT. OF WATER.
DELIVERY HEAD = 33.7 FT. OF WATER.

I. H. P. = 191.5



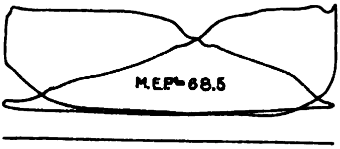
I. H. P. = 144.8



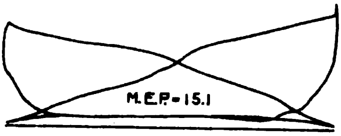
I. H. P. ON PORT CRANK = 335.7

STEAM PRES. = 144
REV. = 180

I. H. P. = 232.7



I. H. P. = 189.6



I. H. P. ON STARBOARD CRANK = 358.3
TOTAL I. H. P. = 688.0

HYDROGRAPH SHOWING STAGE OF RIVER

During the Low Water Season of 1897.

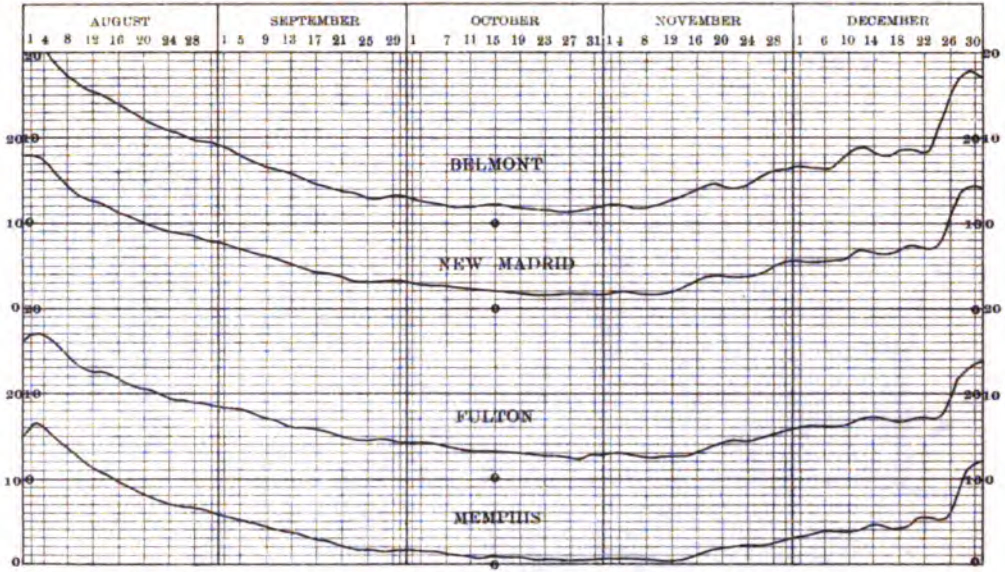
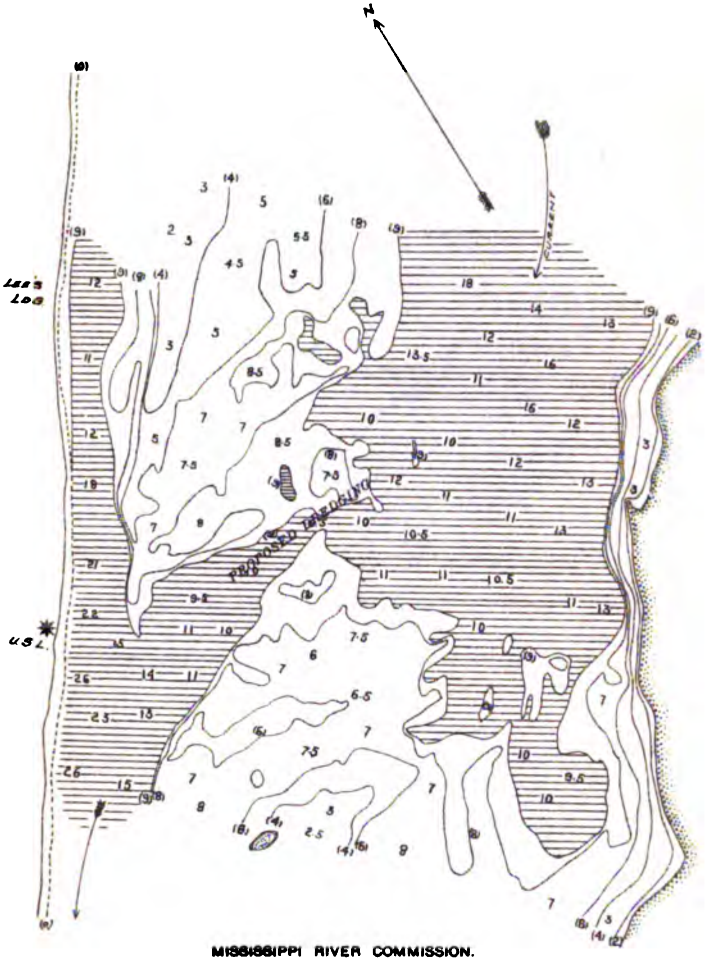


PLATE 30.

Eng 55 3



MISSISSIPPI RIVER COMMISSION.

MAP of MEDLEYS CROSSING (30 R)

(BEFORE DREDGING).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

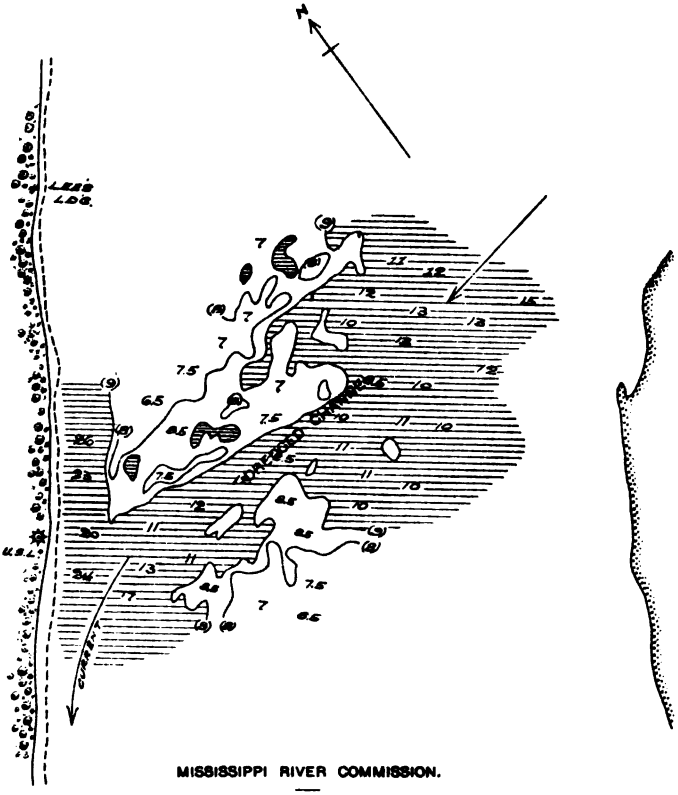
Survey of October 11, 1887.

SCALE OF FEET:

NOTE.—Soundings are referred to mean low water on Belmont gauge, which corresponds to a reading of 3.6 feet.

Gauge at time of survey 2.4 feet, or 1.2 feet below mean low water.

PLATE 31.



MISSISSIPPI RIVER COMMISSION.

MAP of MEDLEYS CROSSING (30 R)

1 DAY AFTER DREDGING. (ALPHA.)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of October 28, 1897.

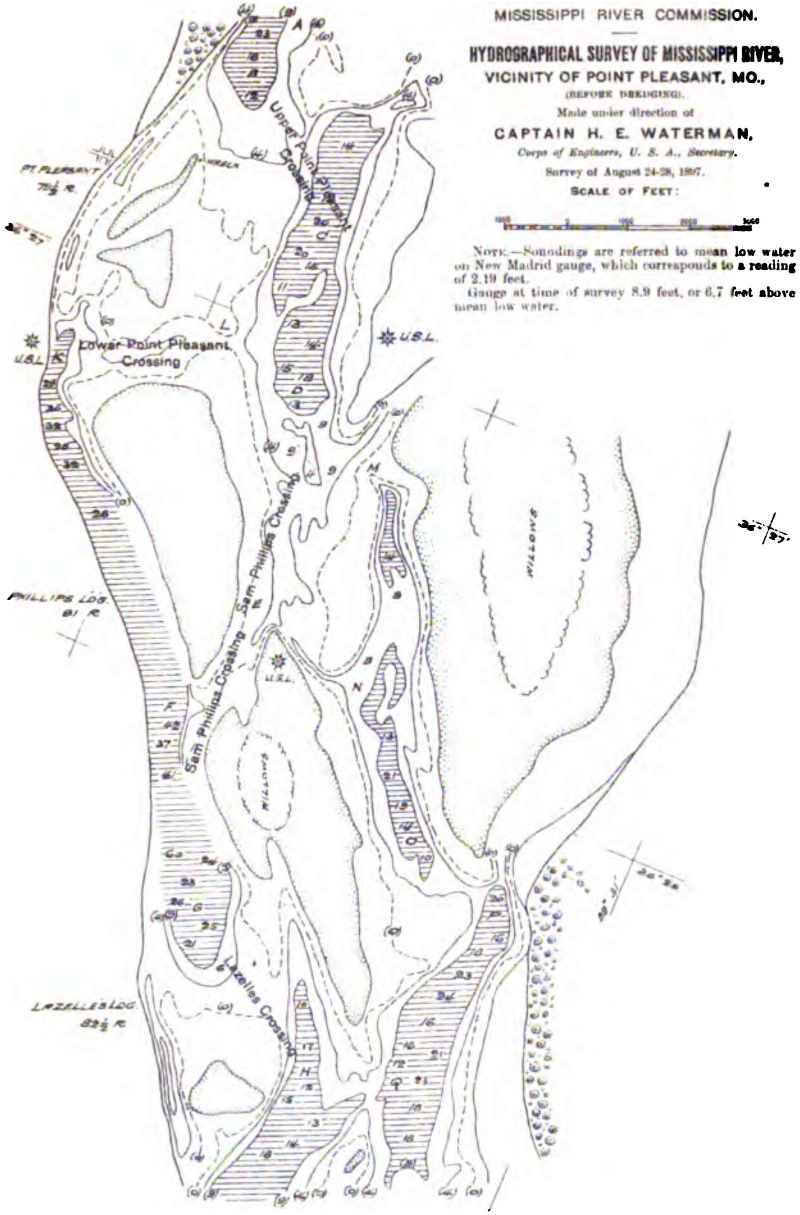
SCALE OF FEET:

600 5 4 3 2 1 0 300 600 900 1200

NOTE.—Soundings are referred to mean low water of the Belmont gauge, which corresponds to a reading of 3.6 feet.

Gauge at time of survey 1.9 feet, or 1.7 feet below mean low water.

PLATE 32.



MISSISSIPPI RIVER COMMISSION.

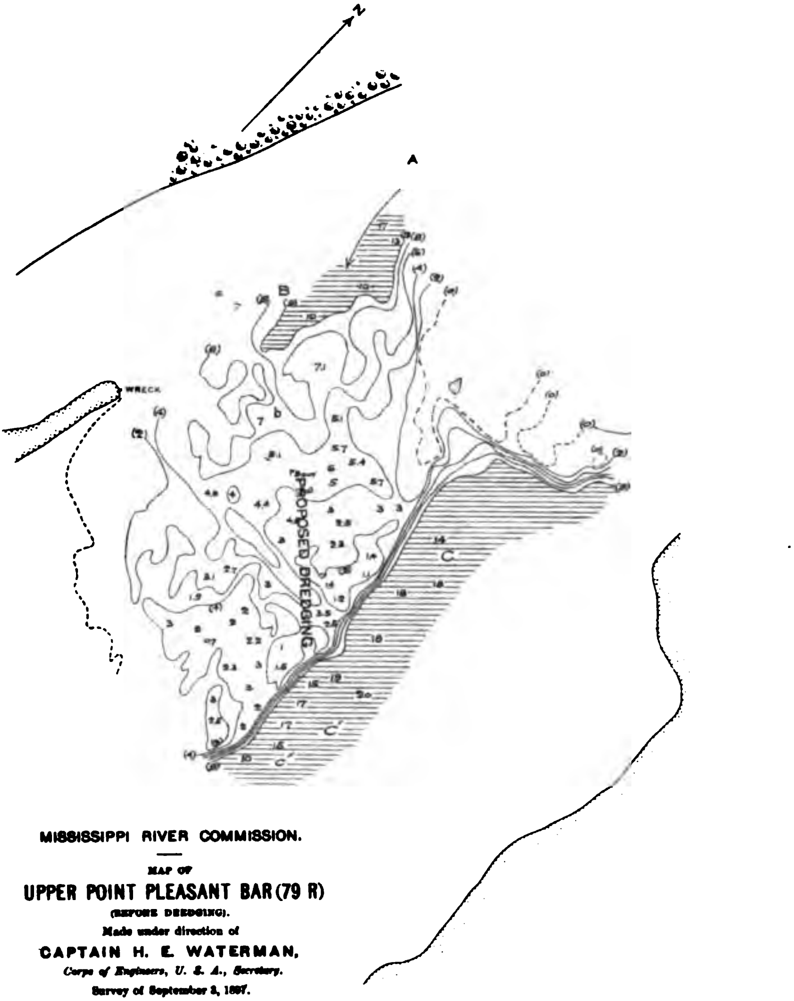
HYDROGRAPHICAL SURVEY OF MISSISSIPPI RIVER,
VICINITY OF POINT PLEASANT, MO.,
(BEFORE DREDGING).
Made under direction of
CAPTAIN H. E. WATERMAN,
Corps of Engineers, U. S. A., Secretary.
Survey of August 24-28, 1897.
SCALE OF FEET:

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.19 feet.

Gauge at time of survey 8.9 feet, or 6.7 feet above mean low water.

PLATE 33.

Eng 55 3



MISSISSIPPI RIVER COMMISSION.

MAP OF

UPPER POINT PLEASANT BAR (79 R)

(BEFORE DREDGING).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

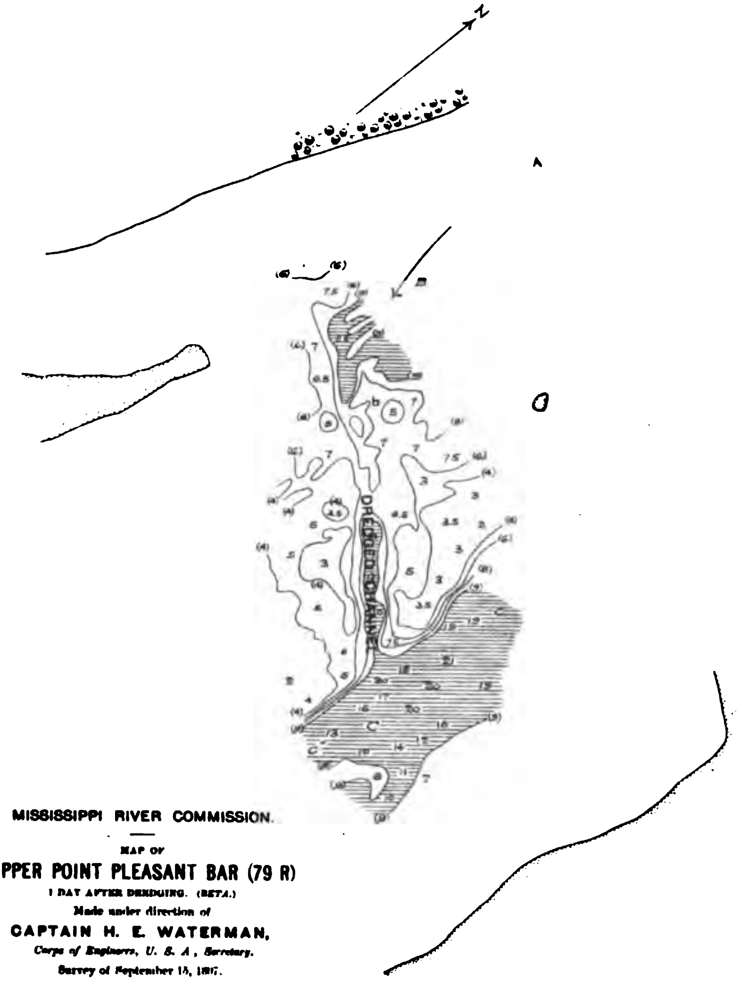
Survey of September 3, 1897.

SCALE OF FEET:

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 7.8 feet, or 5.6 feet above mean low water.

PLATE 34.



MISSISSIPPI RIVER COMMISSION.

MAP OF

UPPER POINT PLEASANT BAR (79 R)

1 DAY AFTER DREDGING. (BETA.)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of September 15, 1897.

SCALE OF FEET:

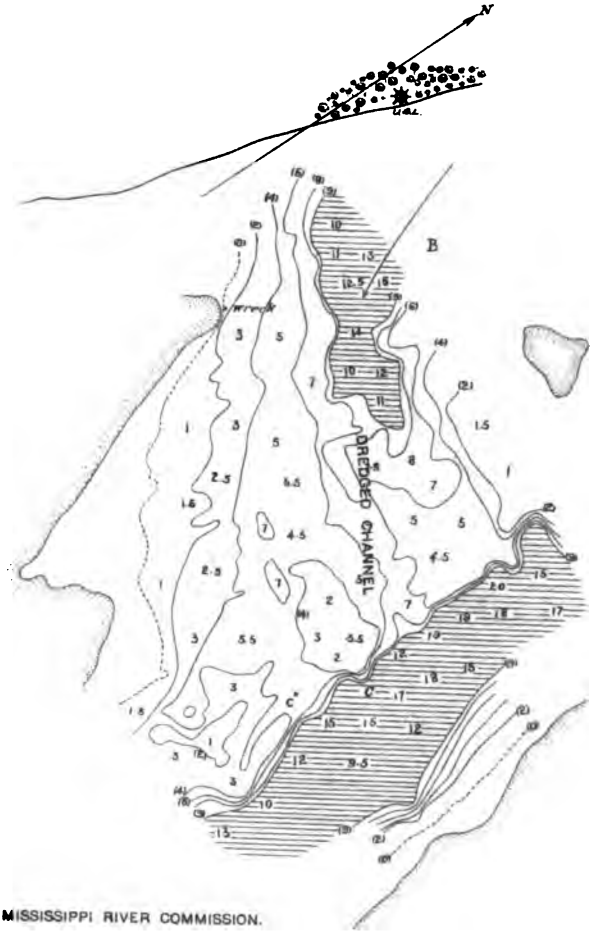
600 5 4 3 2 1 0 300 600 900 1200

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 5.6 feet, or 3.4 feet above mean low water.

✵ U.S.L.

PLATE 35.



MISSISSIPPI RIVER COMMISSION.

MAP OF

UPPER POINT PLEASANT BAR (79 R)

[illegible] DAYS AFTER DREDGING. (*BETA.*)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of October 7. 1897.

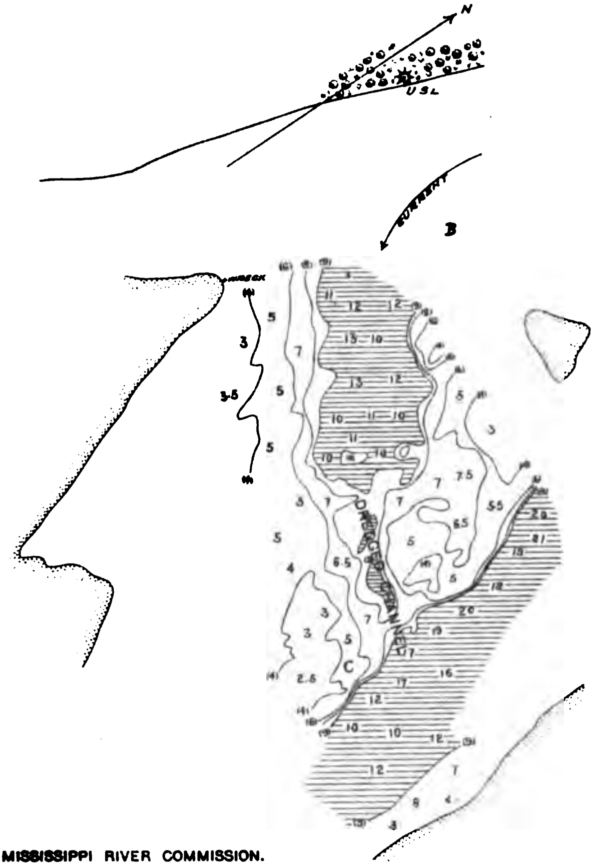
SCALE OF FEET:

✹ U & L

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 3.5 feet, or 1.3 feet above mean low water.

PLATE 36.



MISSISSIPPI RIVER COMMISSION.

MAP OF

UPPER POINT PLEASANT BAR (79 R)

3 DAYS AFTER DREDGING. (*GAMMA.*)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of October 21-22, 1897.

SCALE OF FEET:

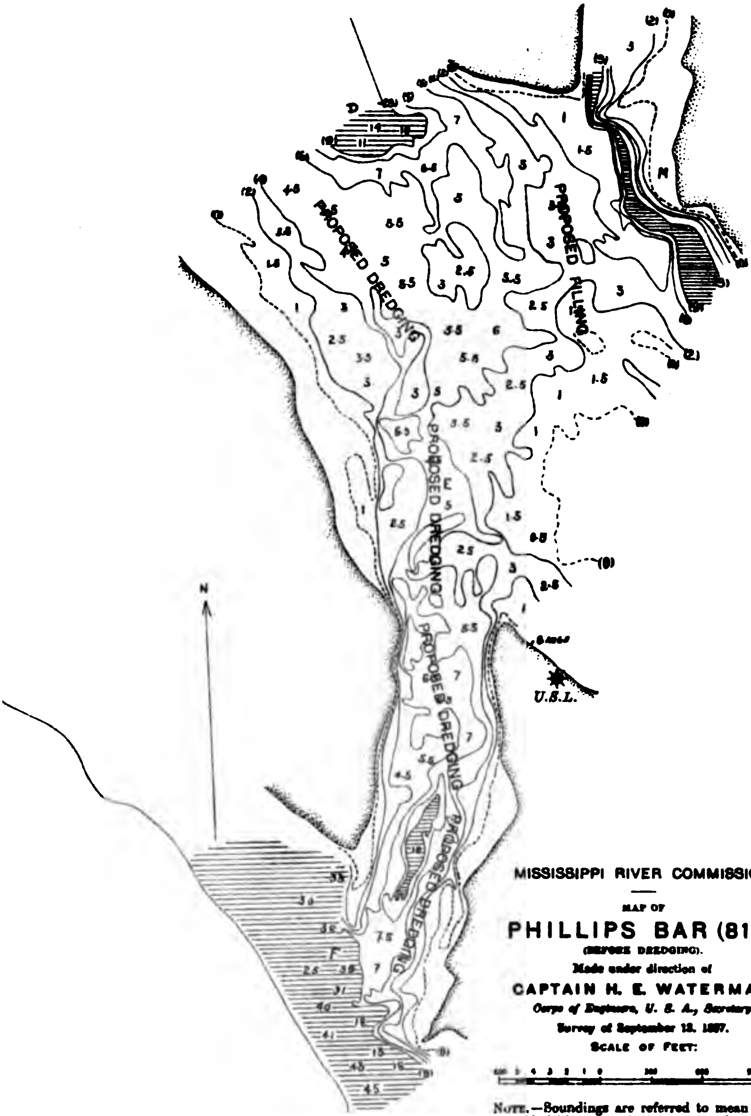
600 5 4 3 2 1 0 300 600 900 1200

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 3.3 feet, or 1.1 feet above mean low water.

✷ U S L

PLATE 37.



MISSISSIPPI RIVER COMMISSION.

MAP OF

PHILLIPS BAR (81 R)

(BEFORE DREDGING).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

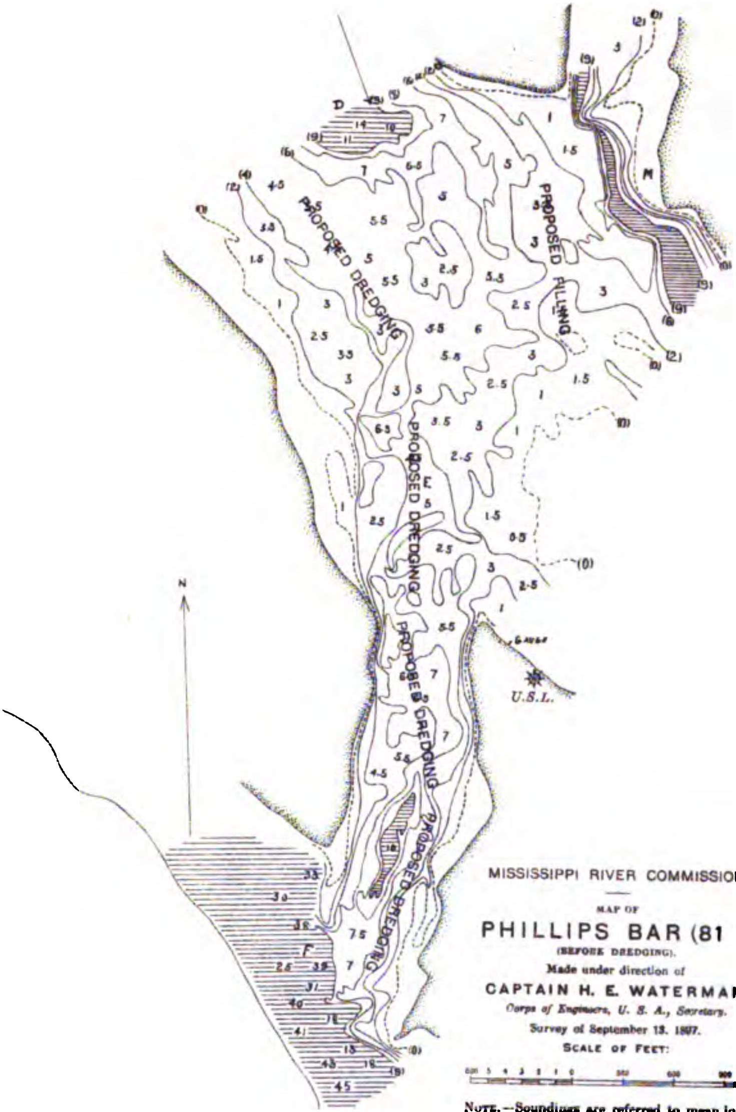
Survey of September 12, 1897.

SCALE OF FEET:

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 5.9 feet, or 3.7 feet above mean low water.

PLATE 40.



MISSISSIPPI RIVER COMMISSION.

MAP OF

PHILLIPS BAR (81 R)

(BEFORE DREDGING).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

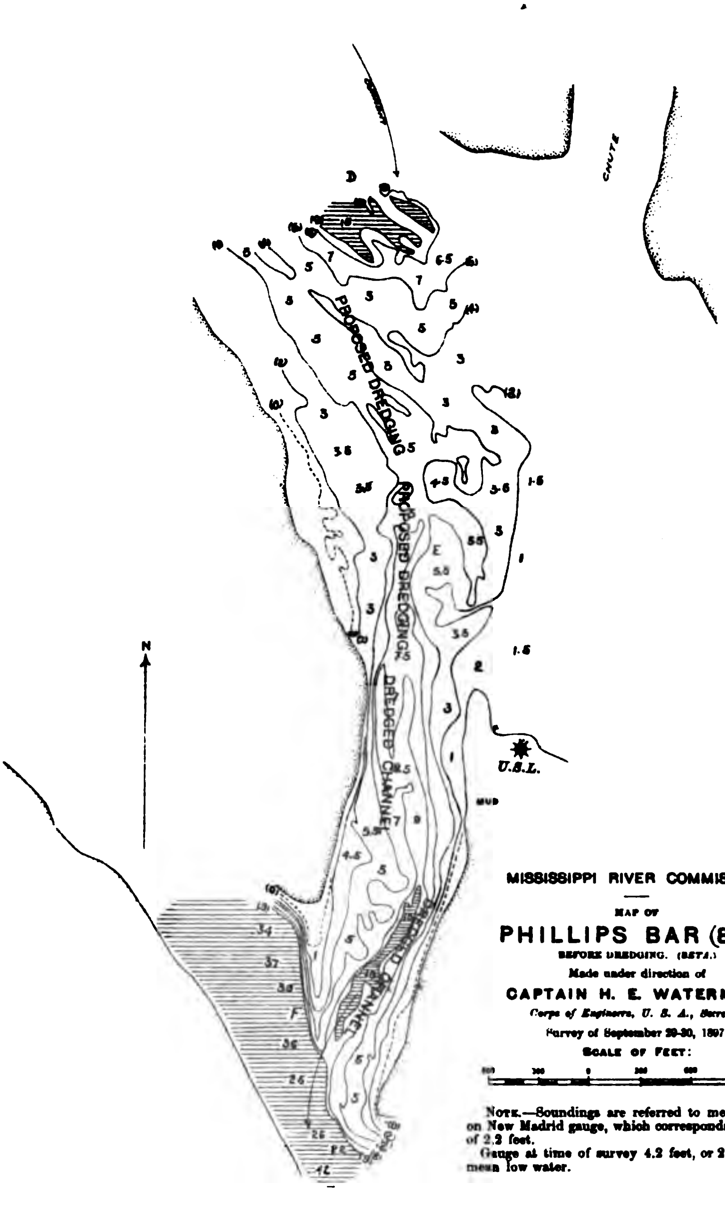
Survey of September 13, 1897.

SCALE OF FEET:

Note.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 5.9 feet, or 3.7 feet above mean low water.

PLATE 40.



MISSISSIPPI RIVER COMMISSION.

MAP OF

PHILLIPS BAR (81 R)

BEFORE DREDGING. (BETA.)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of September 29-30, 1897.

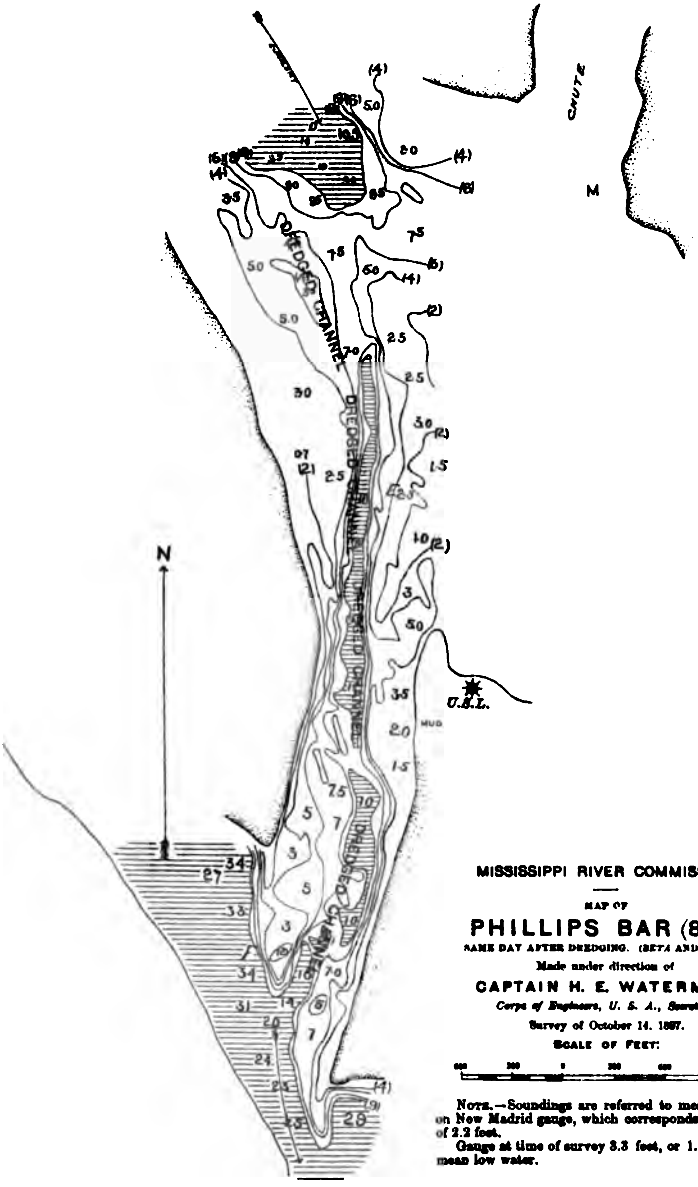
SCALE OF FEET:

600 300 0 300 600 900 1200

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 4.2 feet, or 2.0 feet above mean low water.

PLATE 41.



MISSISSIPPI RIVER COMMISSION.

MAP OF

PHILLIPS BAR (81 R)

SAME DAY AFTER DREDGING. (*BETA AND GAMMA*).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of October 14. 1887.

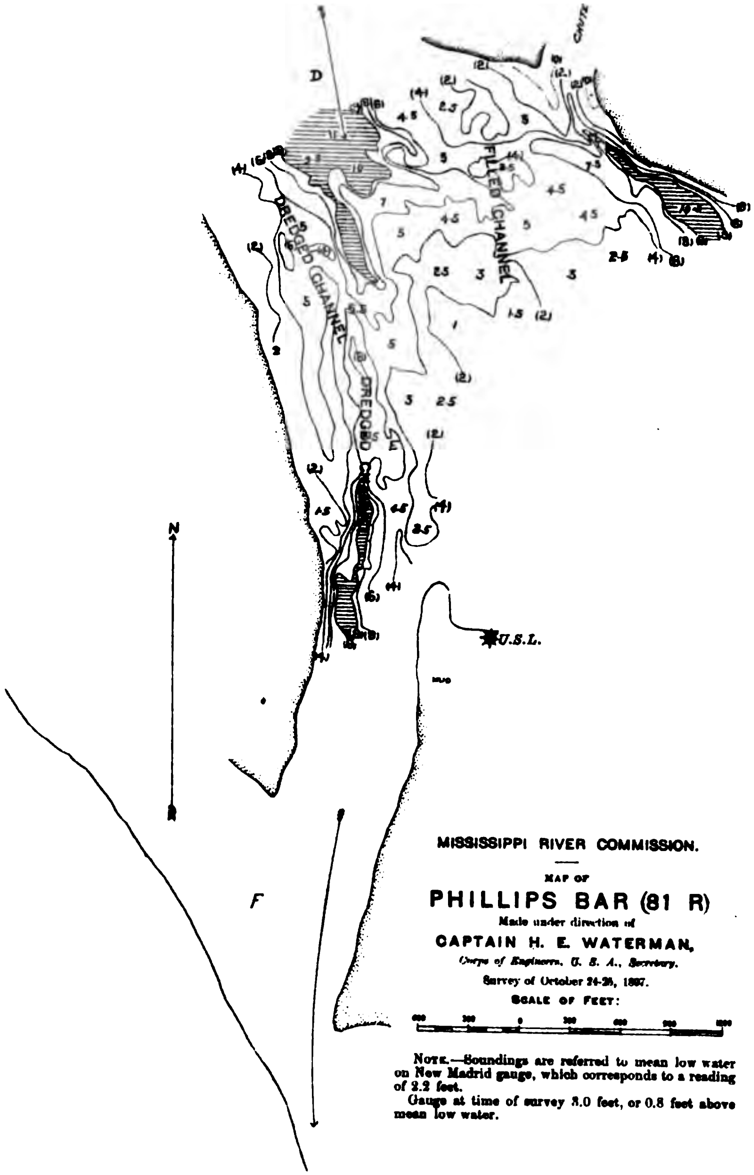
SCALE OF FEET:

600 300 0 300 600 900 1200

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 3.3 feet, or 1.1 feet above mean low water.

PLATE 42.



MISSISSIPPI RIVER COMMISSION.

MAP OF

PHILLIPS BAR (81 R)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

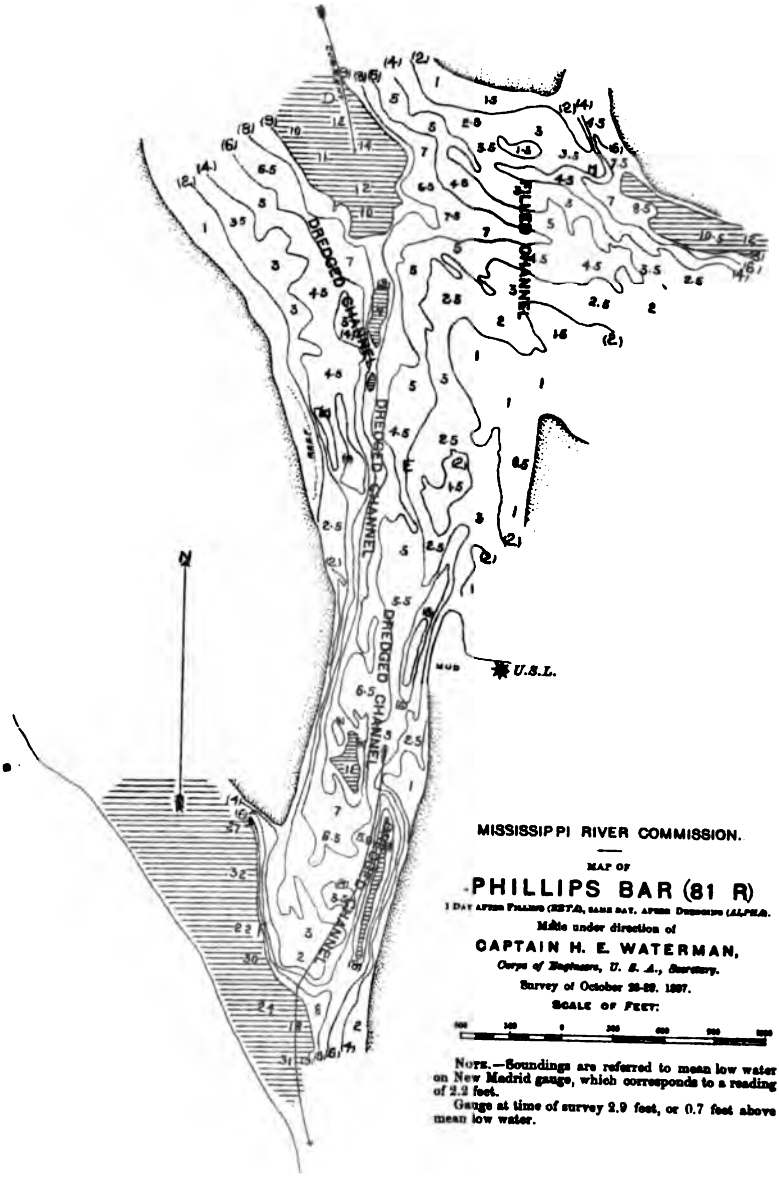
Survey of October 24-26, 1887.

SCALE OF FEET:

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 3.0 feet, or 0.8 feet above mean low water.

PLATE 43.



MISSISSIPPI RIVER COMMISSION.

MAP OF

PHILLIPS BAR (81 R)

1 DAY AFTER FILLING (BETA), SAME DAY, AFTER DREDGING (ALPHA).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of October 28-29. 1897.

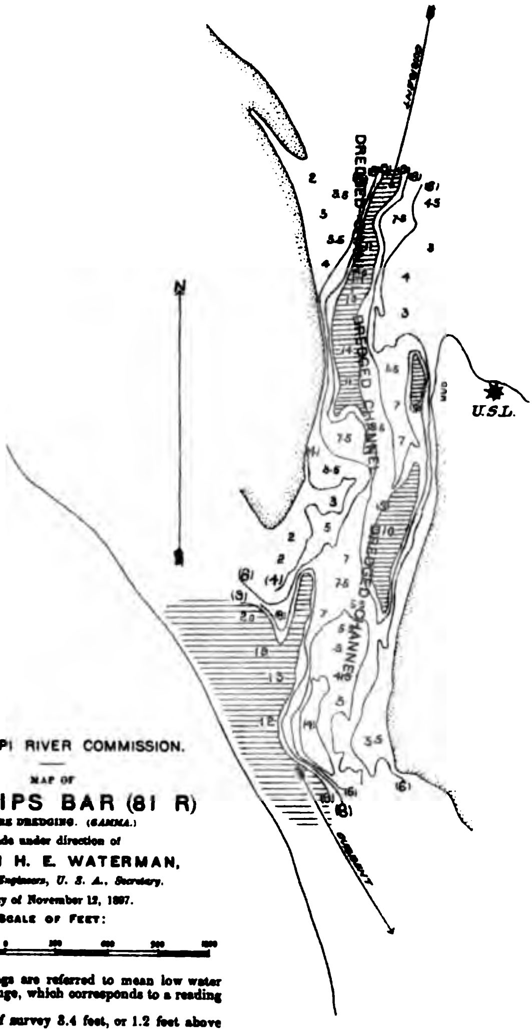
SCALE OF FEET:

600 300 0 300 600 900 1200

Note.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 2.9 feet, or 0.7 feet above mean low water.

PLATE 44.



MISSISSIPPI RIVER COMMISSION.

MAP OF

PHILLIPS BAR (81 R)

BEFORE DREDGING. (*GAMMA.*)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 12, 1897.

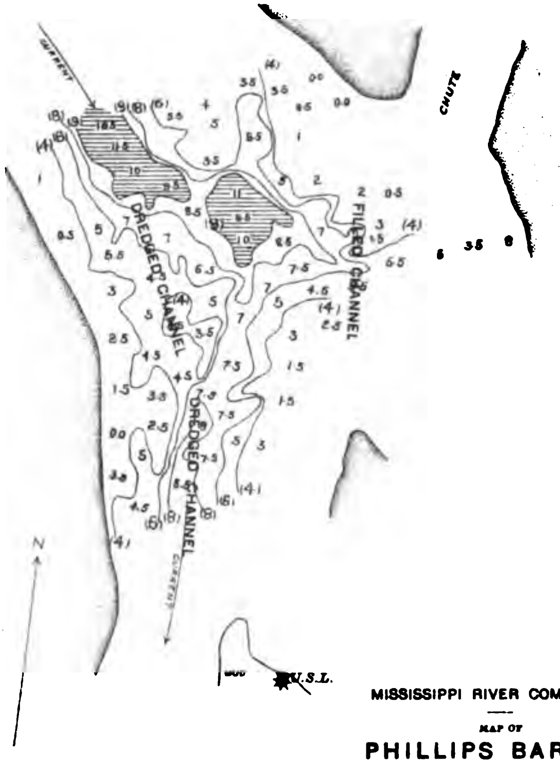
SCALE OF FEET:

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 3.4 feet, or 1.2 feet above mean low water.

PLATE 45.

Eng 55 3



MISSISSIPPI RIVER COMMISSION.

MAP OF

PHILLIPS BAR (81 R)

DURING DREDGING. (1897).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 14, 1897.

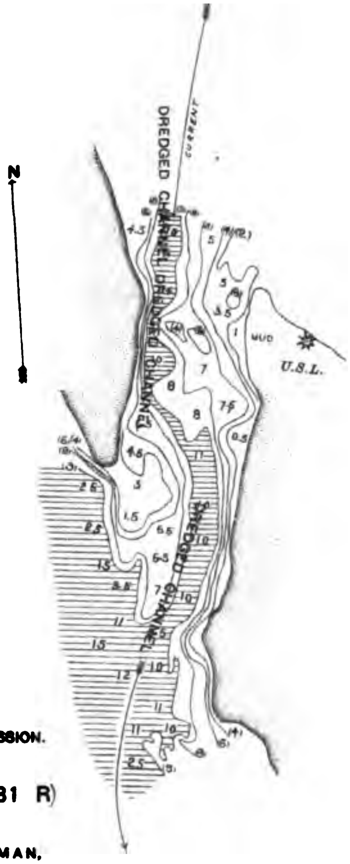
SCALE OF FEET:

400 200 0 200 400 600 800

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 3.6 feet, or 1.4 feet above mean low water.

PLATE 46.



MISSISSIPPI RIVER COMMISSION.

MAP OF

PHILLIPS BAR (81 R)

AFTER DREDGING. (GAMMA.)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 17, 1897.

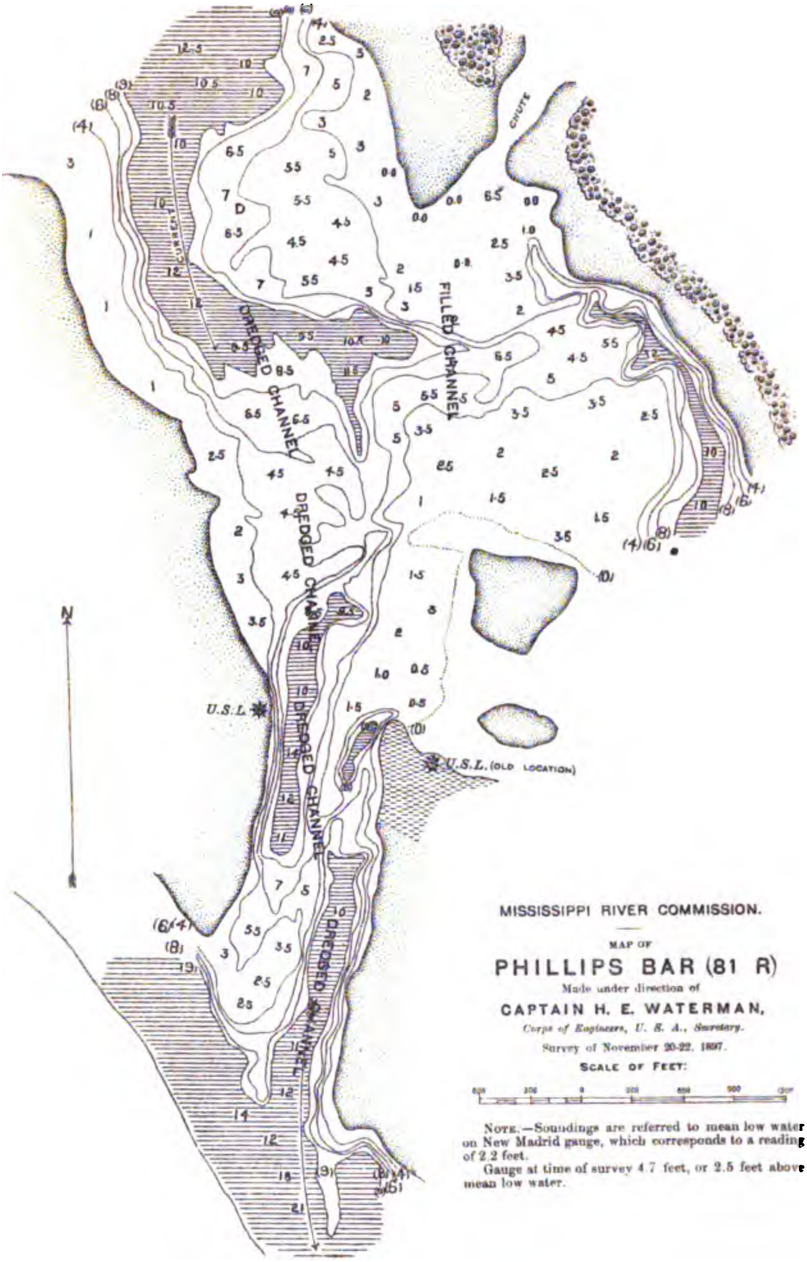
SCALE OF FEET:

600 300 0 300 600 900 1200

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 4.7 feet, or 2.5 feet above mean low water.

PLATE 47.



MISSISSIPPI RIVER COMMISSION.

MAP OF

PHILLIPS BAR (81 R)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 20-22, 1897.

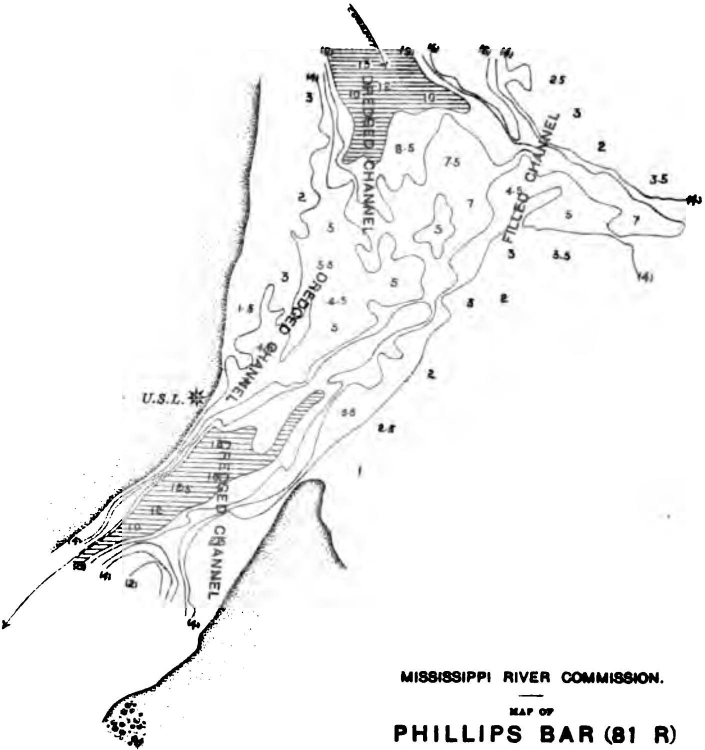
SCALE OF FEET:

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 4.7 feet, or 2.5 feet above mean low water.

PLATE 48.

Eng 55 3



MISSISSIPPI RIVER COMMISSION.

MAP OF

PHILLIPS BAR (81 R)

AFTER FILLING. (GAMMA).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of December 1, 1897.

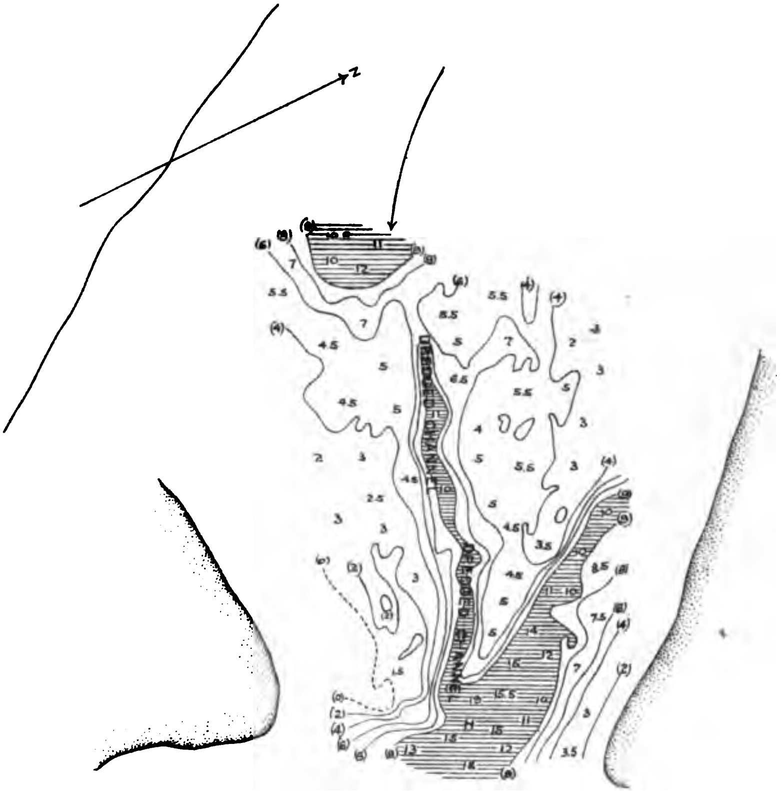
SCALE OF FEET:

600 300 0 300 600 900 1200

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 6.5 feet, or 4.3 feet above mean low water.

PLATE 49.



MISSISSIPPI RIVER COMMISSION.

MAP OF

LAZELLES BAR (821-2) R

1 DAY AFTER DREDGING. (GAMMA.)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of September 16, 1897.

SCALE OF FEET:

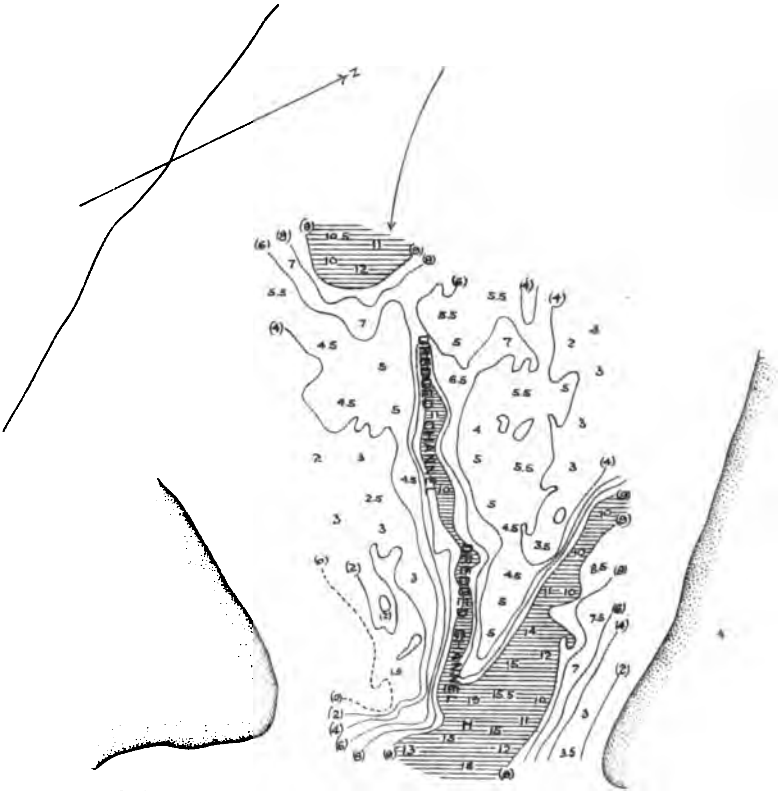
400 200 0 200 400 600 800

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 4.7 feet, or 2.5 feet above mean low water.

PLATE 51.

Eng 55 3



MISSISSIPPI RIVER COMMISSION.

MAP OF

LAZELLES BAR (821-2) R

1 DAY AFTER DREDGING. (GAMMA.)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of September 16, 1897.

SCALE OF FEET:

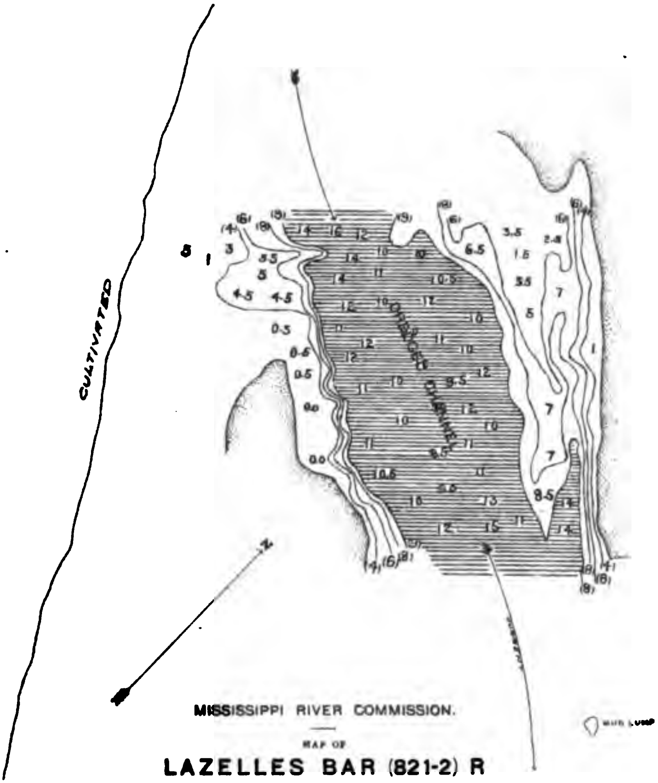
400 200 0 200 400 600 800

○ MUD LUMP

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 4.7 feet, or 2.5 feet above mean low water.

PLATE 51.



MISSISSIPPI RIVER COMMISSION.

MAP OF

LAZELLES BAR (821-2) R

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 30, 1897.

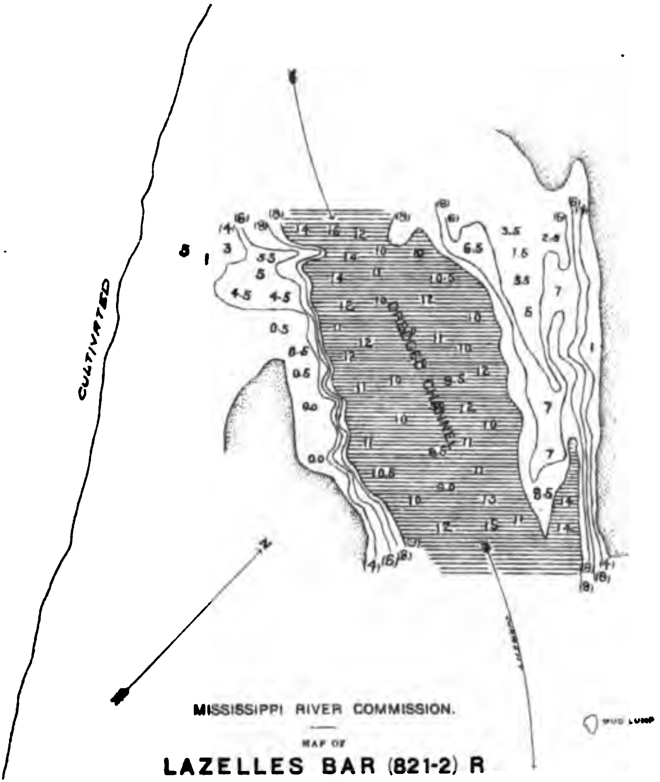
SCALE OF FEET:

600 300 0 300 600 900 1200

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 5.5 feet, or 3.3 feet above mean low water.

PLATE 53.



MISSISSIPPI RIVER COMMISSION.

MAP OF

LAZELLES BAR (821-2) R

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

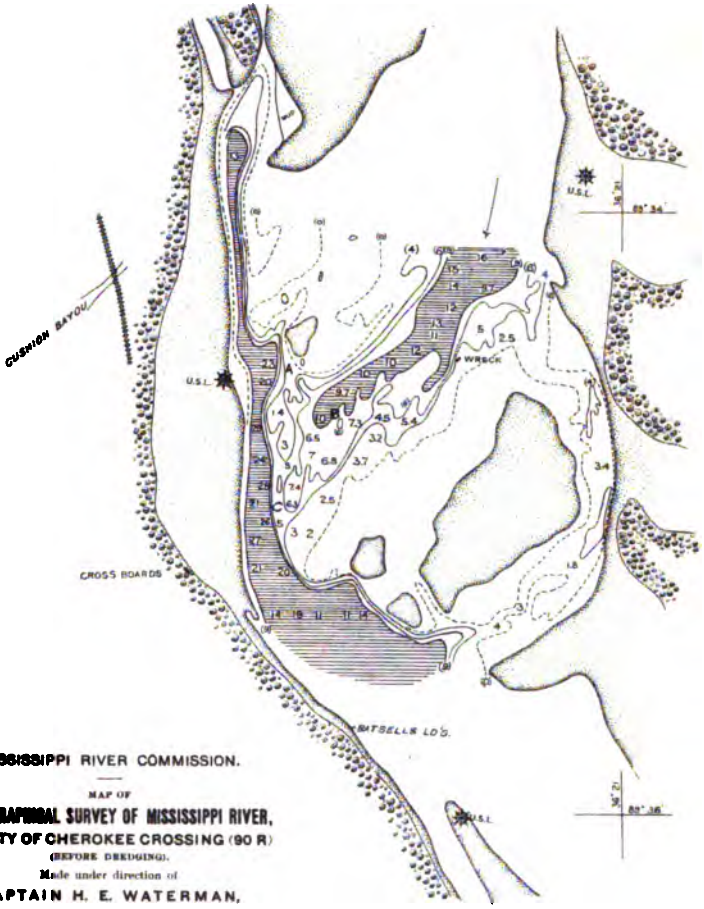
Survey of November 30, 1897.

SCALE OF FEET:

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 5.5 feet, or 3.3 feet above mean low water.

PLATE 53.



MISSISSIPPI RIVER COMMISSION.

MAP OF

HYDROGRAPHICAL SURVEY OF MISSISSIPPI RIVER, VICINITY OF CHEROKEE CROSSING (90 R)

(BEFORE DREDGING).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of September 9-11, 1897.

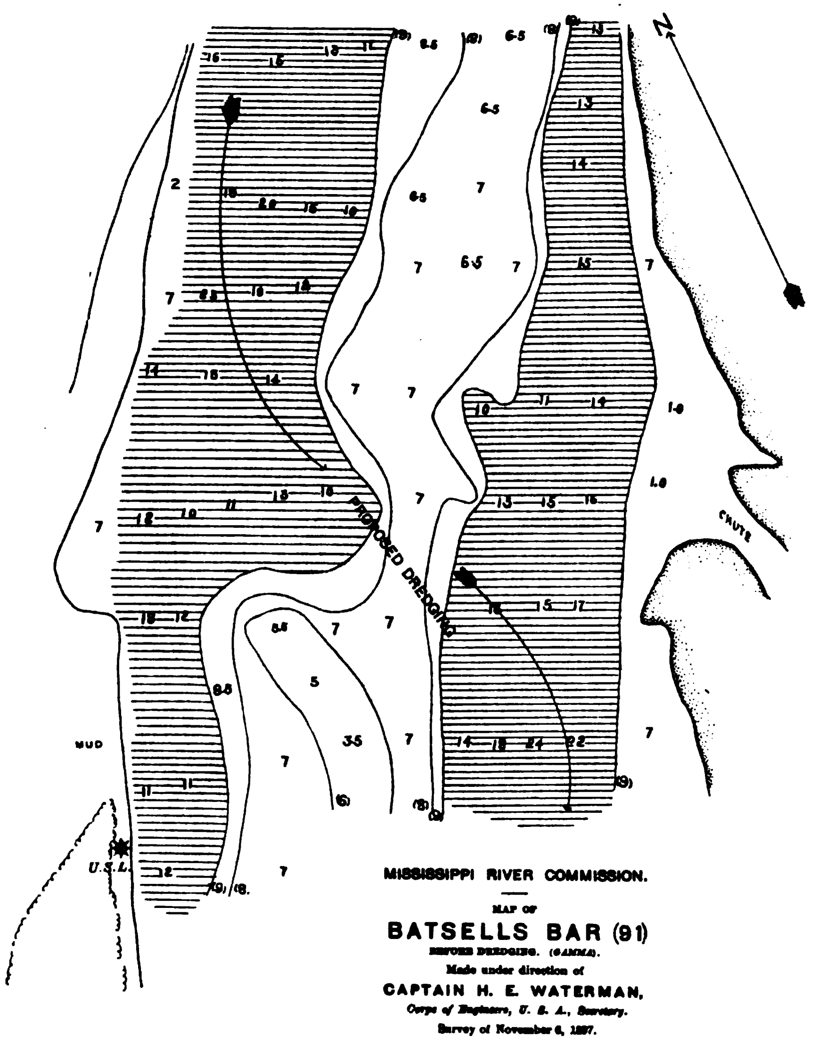
SCALE OF FEET:

1000 0 1000 2000 3000 4000

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 5.8 feet, or 3.6 feet above mean low water.

PLATE 54.



MISSISSIPPI RIVER COMMISSION.

MAP OF

BATSELLS BAR (91)

BEFORE DREDGING. (GAMMA).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 6, 1897.

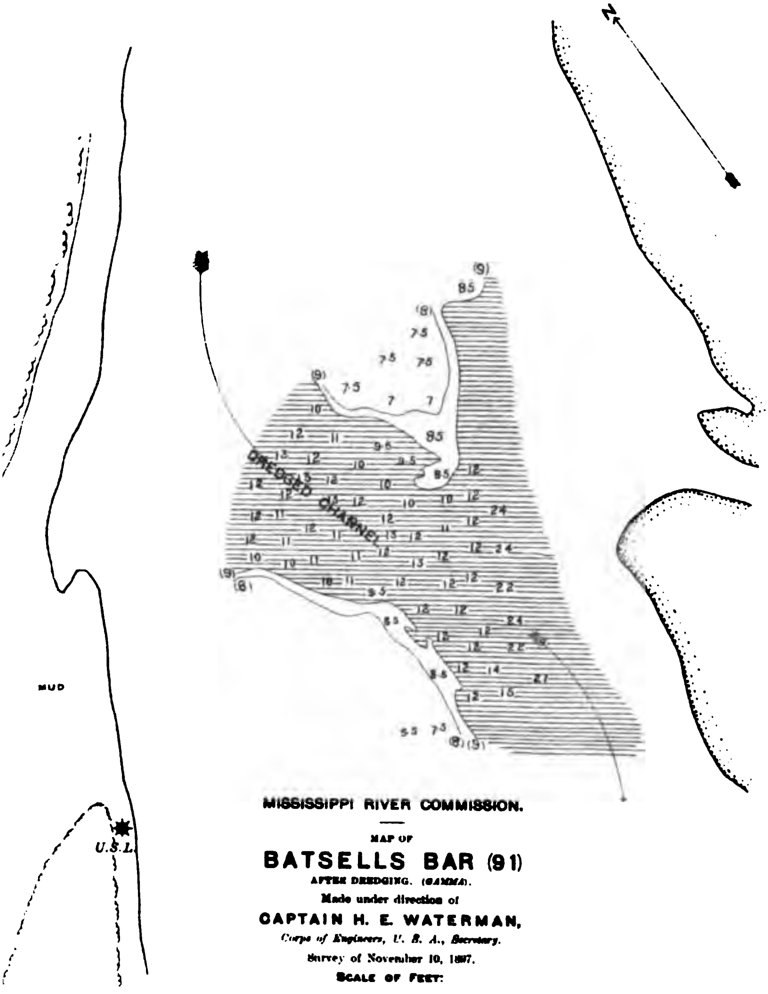
SCALE OF FEET:

400 200 0 200 400 600 800

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 1.7 feet, or 0.5 feet above mean low water.

PLATE 55.



MISSISSIPPI RIVER COMMISSION.

MAP OF

BATSELLS BAR (91)

AFTER DREDGING. (*GAMMA*).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

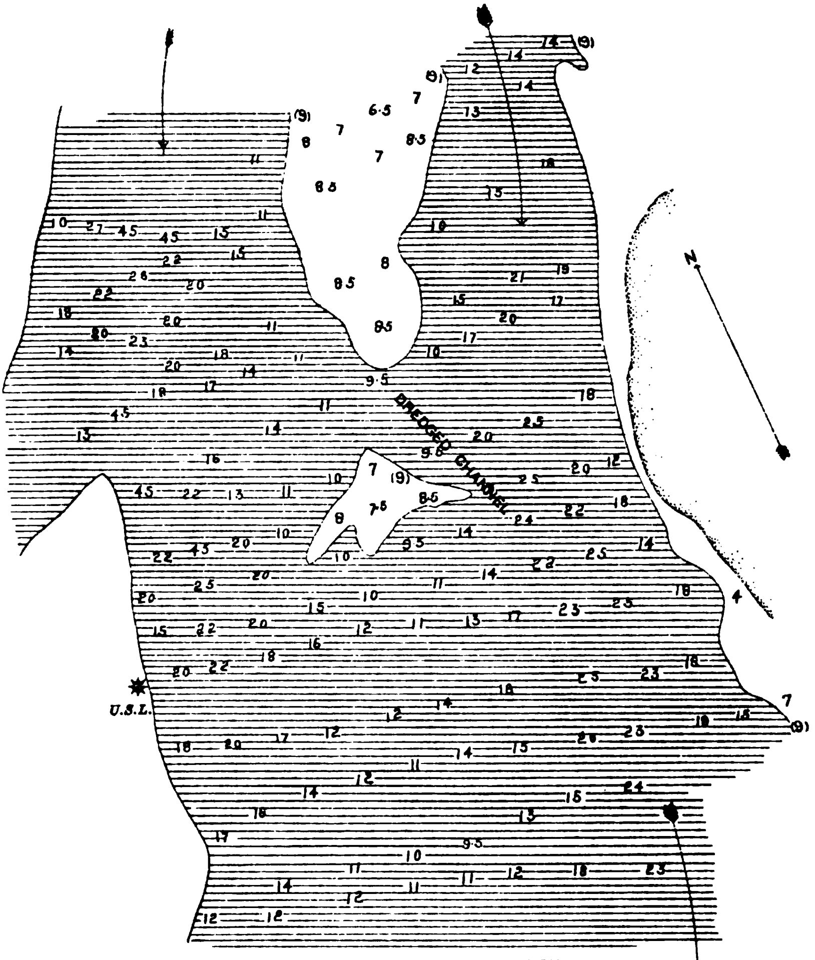
Survey of November 10, 1897.

SCALE OF FEET:

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 1.6 feet, or 0.6 feet below mean low water.

PLATE 56.



MISSISSIPPI RIVER COMMISSION.

MAP OF

BATSELLS BAR (91)

30 DAYS AFTER DREDGING. (GAMMA.)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of December 19, 1897.

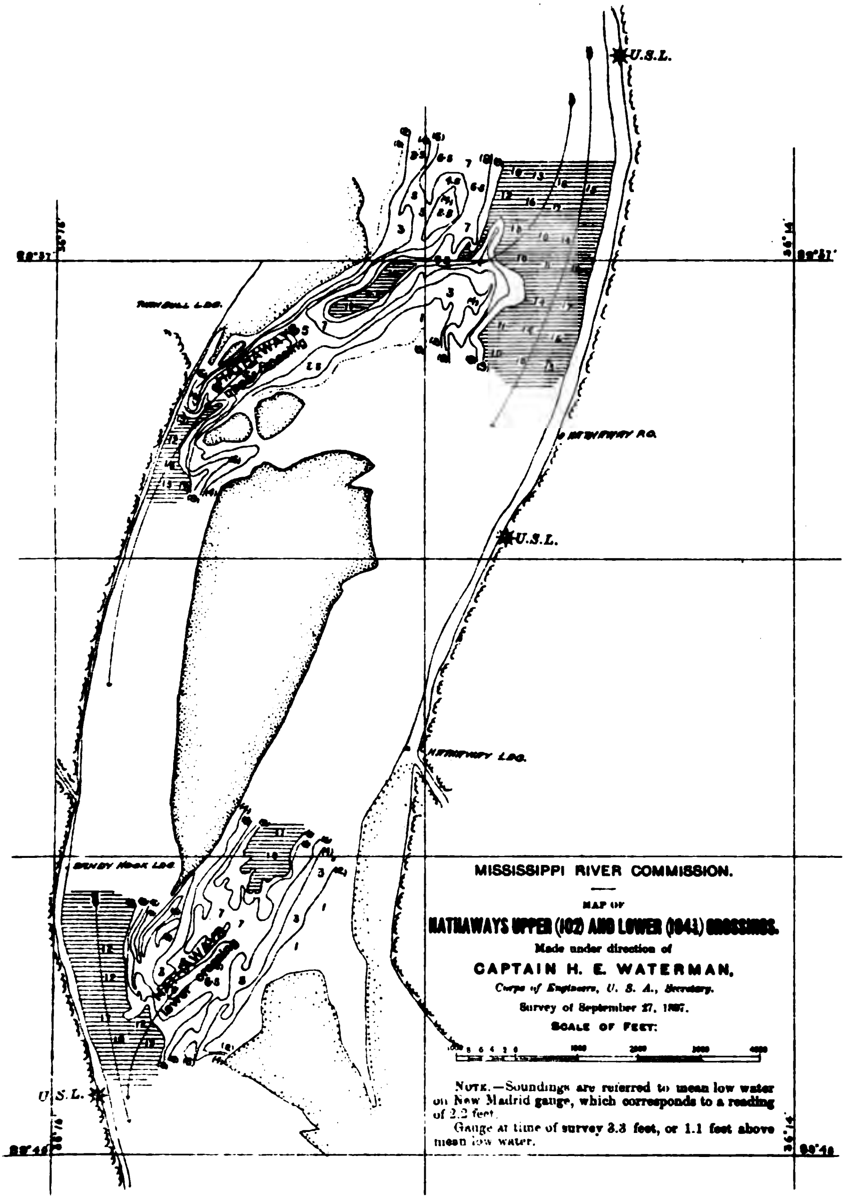
SCALE OF FEET:

400 200 0 200 400 600 800

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 7.25 feet, or 5.05 feet above mean low water.

PLATE 57.



MISSISSIPPI RIVER COMMISSION.

MAP OF

HATHAWAYS UPPER (102) AND LOWER (104½) CROSSINGS.

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of September 27, 1887.

SCALE OF FEET:

1000 8 6 4 2 0 1000 2000 3000 4000

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 3.3 feet, or 1.1 feet above mean low water.

PLATE 58.

Eng 55 3

MISSISSIPPI RIVER COMMISSION.

MAP OF

HATHAWAYS LOWER CROSSING (104½)

BEFORE DREDGING. (GAMMA).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of October 18-19, 1897.

SCALE OF FEET:

600 300 0 300 600 900 1200

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 1.9 feet, or 0.3 feet below mean low water.

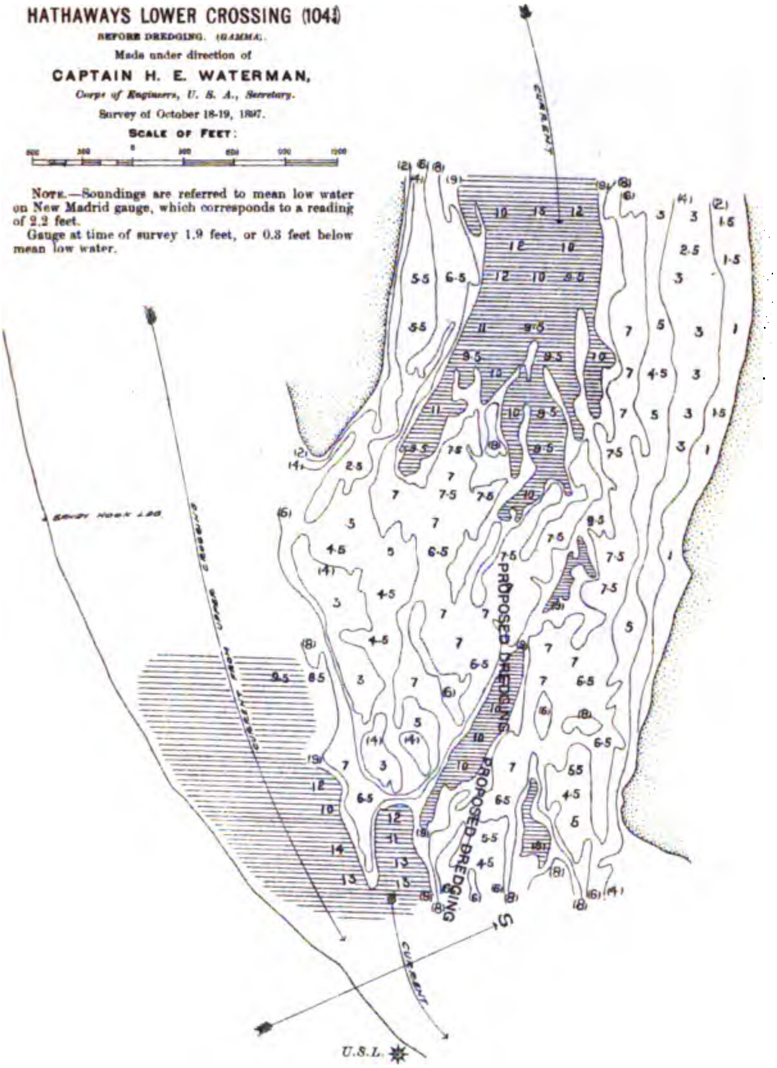
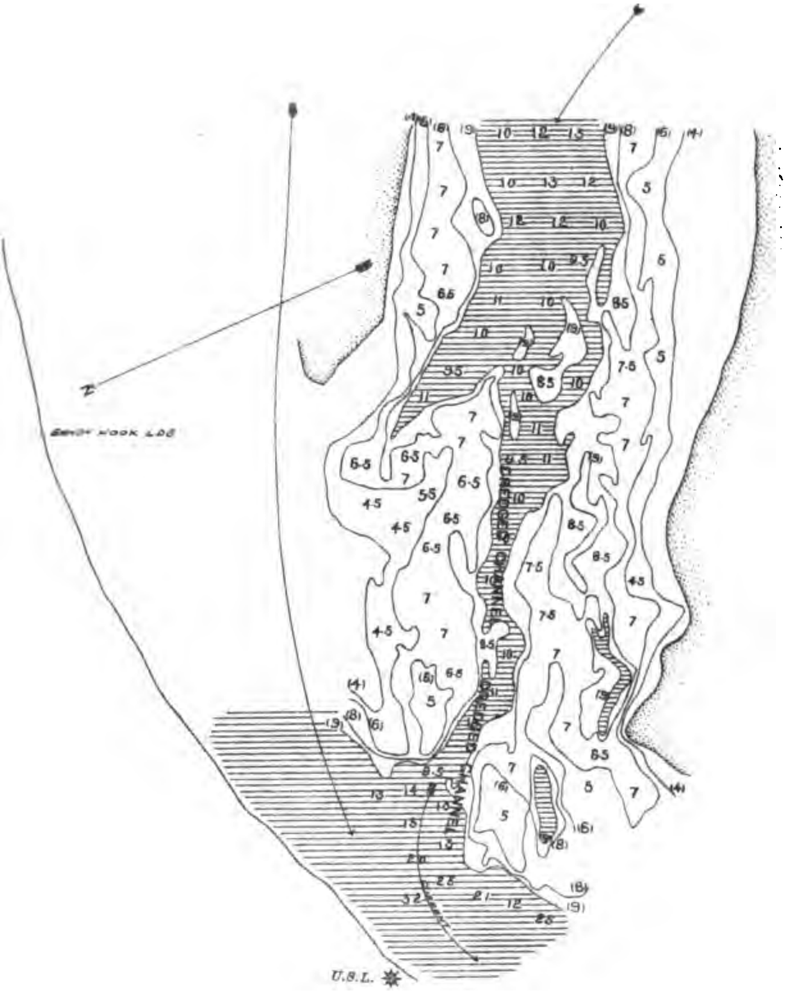


PLATE 59.



MISSISSIPPI RIVER COMMISSION.

MAP OF

HATHAWAYS LOWER CROSSING (1041)

1½ DAYS AFTER DREDGING. (GAMMA).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of October 31, 1897.

SCALE OF FEET:

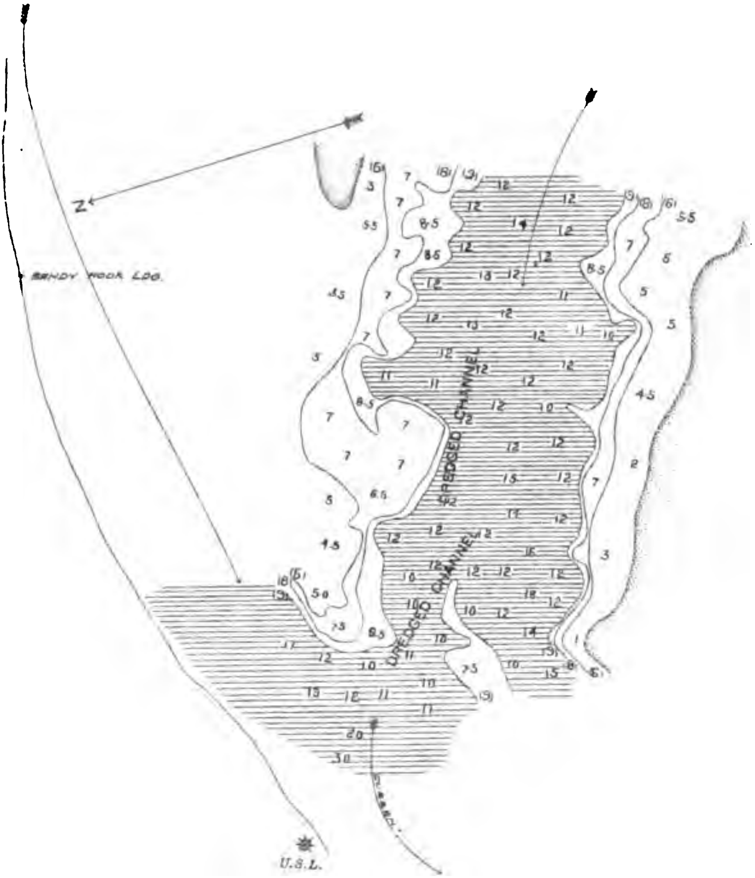
600 300 0 300 600 900 1200

NOTE.—Soundings are referred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 1.8 feet, or 0.4 feet below mean low water.

PLATE 60.

Eng 55 3



MISSISSIPPI RIVER COMMISSION.

MAP OF

HATHAWAYS LOWER CROSSING (104¼)

21 DAYS AFTER DREDGING. *(GAMMA)*.

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 29, 1897.

SCALE OF FEET:

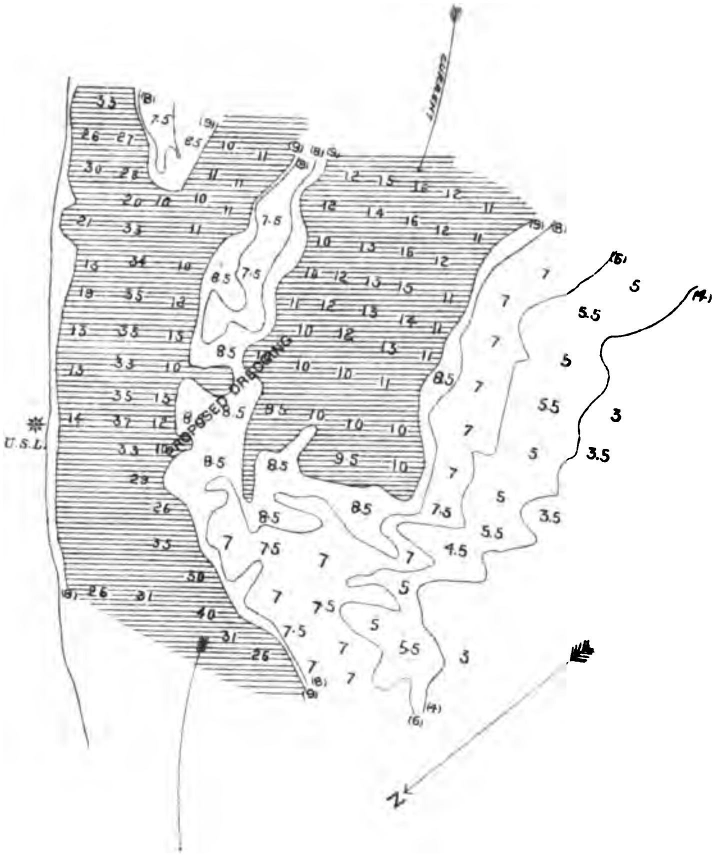
300 150 0 300 600 900 1200

NOTE.—Soundings are reforred to mean low water on New Madrid gauge, which corresponds to a reading of 2.2 feet.

Gauge at time of survey 5.4 feet, or 3.2 feet above mean low water.

PLATE 61.

Eng 55 3



MISSISSIPPI RIVER COMMISSION.

MAP OF

GOLD DUST CROSSING (158)

BEFORE DREDGING. (*ALPHA*).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 1, 1897.

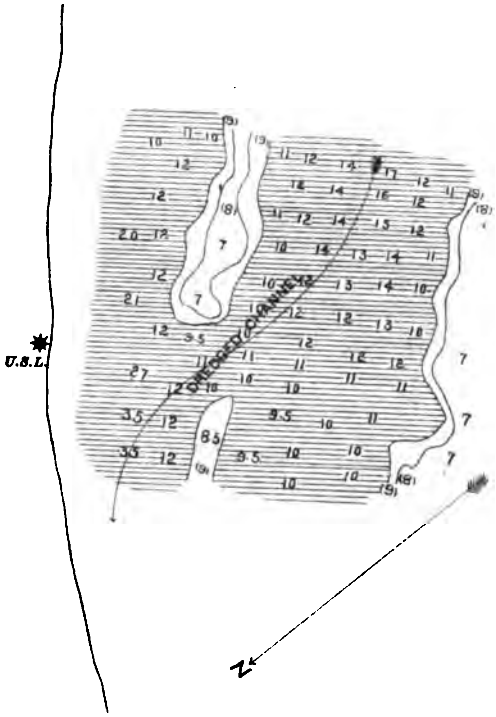
SCALE OF FEET:

400 200 0 200 400 600 800

NOTE.—Soundings are referred to mean low water on Fulton gauge, which corresponds to a reading of 3.88 feet.

Gauge at time of survey 2.9 feet, or 0.98 feet below mean low water.

PLATE 62.



MISSISSIPPI RIVER COMMISSION.

MAP OF

GOLD DUST CROSSING (158)

AFTER DREDGING. (*ALPHA.*)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 12, 1907.

SCALE OF FEET:

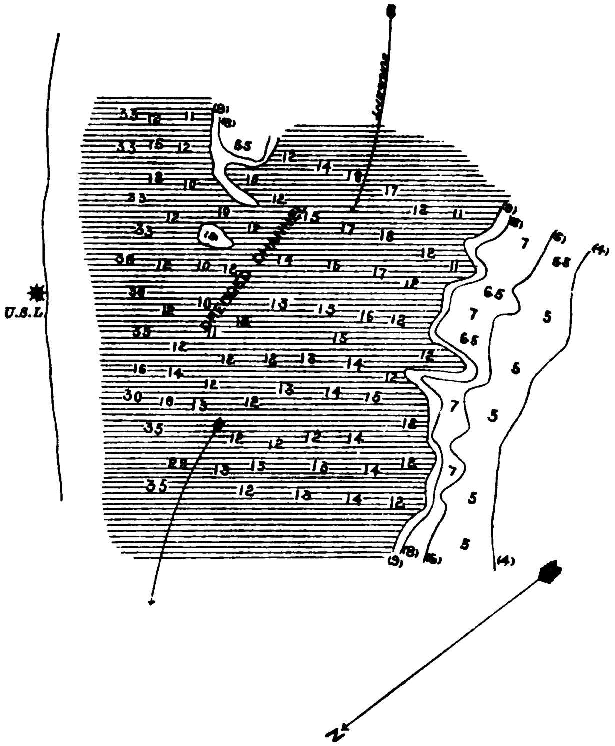
400 200 0 200 400 600 800

NOTE.—Soundings are referred to mean low water on Fulton gauge, which corresponds to a reading of 3.88 feet.

Gauge at time of survey 2.9 feet, or 0.98 feet below mean low water.

PLATE 63.

Eng 55



MISSISSIPPI RIVER COMMISSION.

MAP OF

GOLD DUST CROSSING (158)

21 DAYS AFTER DREDGING (ALPHA).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 27, 1897.

SCALE OF FEET:

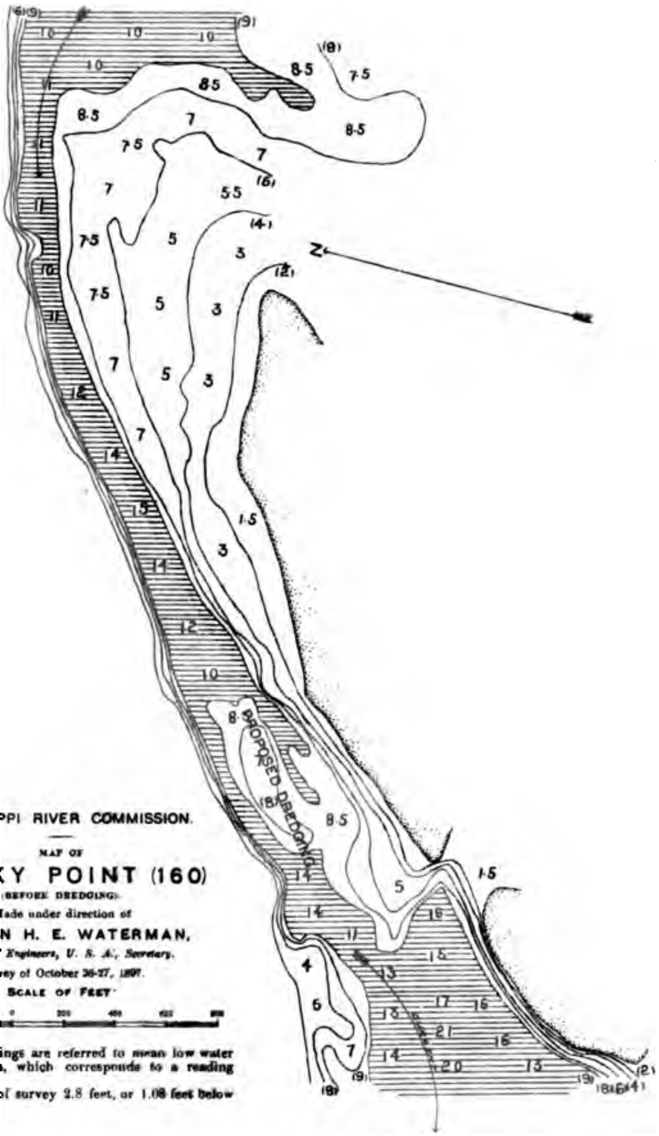
400 200 0 200 400 600 800

NOTE.—Soundings are referred to mean low water on Fulton gauge, which corresponds to a reading of 3.88 feet.

Gauge at time of survey 5.15 feet, or 1.27 feet above mean low water.

PLATE 64.

Eng 55 3



MISSISSIPPI RIVER COMMISSION.

MAP OF

ROCKY POINT (160)

(BEFORE DREDGING)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

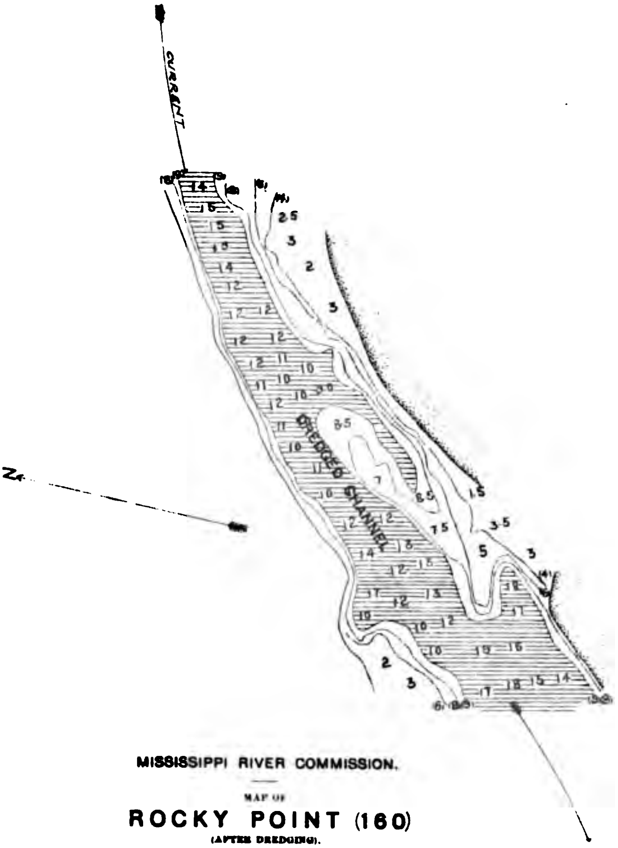
Survey of October 26-27, 1897.

SCALE OF FEET

NOTE.—Soundings are referred to mean low water on Fulton gauge, which corresponds to a reading of 3.88 feet.

Gauge at time of survey 2.8 feet, or 1.08 feet below mean low water.

PLATE 65.



MISSISSIPPI RIVER COMMISSION.

MAP OF

ROCKY POINT (160)

(AFTER DREDGING).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 12, 1897.

SCALE OF FEET:

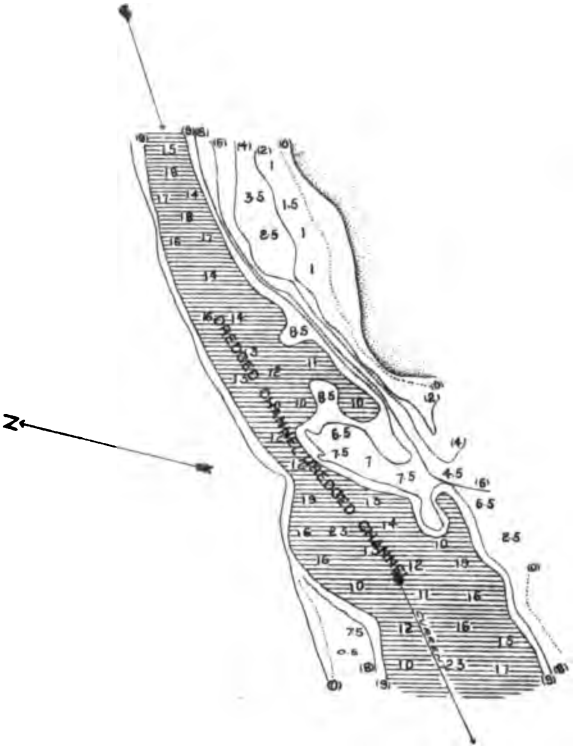
400 200 0 200 400 600 800

NOTE.—Soundings are referred to mean low water on Fulton gauge, which corresponds to a reading of 3.88 feet.

Gauge at time of survey 2.85 feet, or 1.03 feet below mean low water.

PLATE 66.

Eng 55 3



MISSISSIPPI RIVER COMMISSION.

MAP OF

ROCKY POINT (160)

12 DAYS AFTER DREDGING. (GAMMA.)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 27, 1897.

SCALE OF FEET:

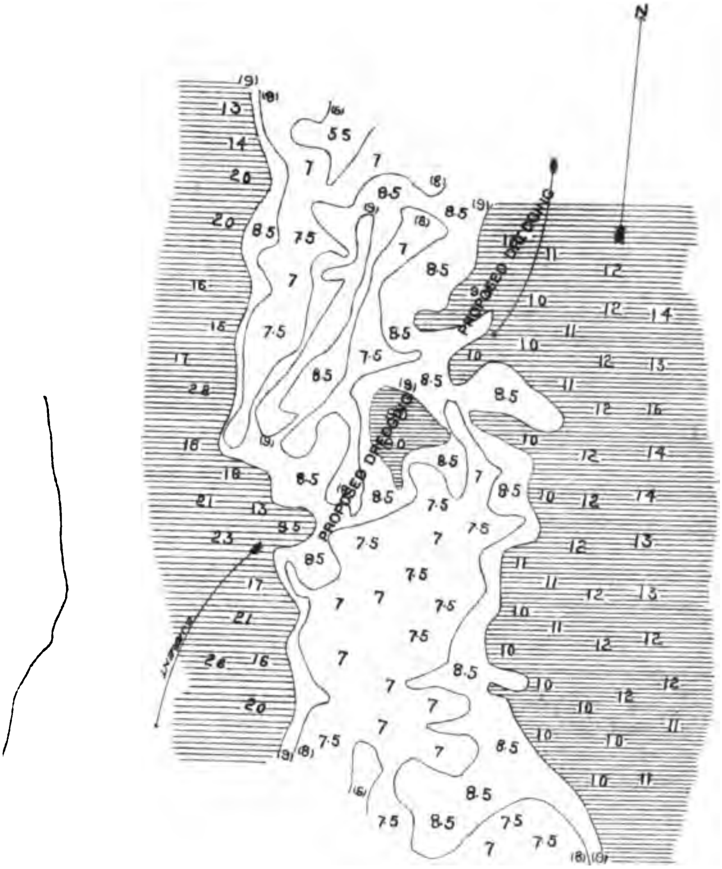
400 200 0 200 400 600 800

NOTE.—Soundings are referred to mean low water on Fulton gauge, which corresponds to a reading of 3.88 feet.

Gauge at time of survey 5.15 feet, or 1.27 feet above mean low water.

PLATE 67.

Eng 55



MISSISSIPPI RIVER COMMISSION.

MAP OF

OSCEOLA BAR (164)

(BEFORE DREDGING).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of October 21, 1897.

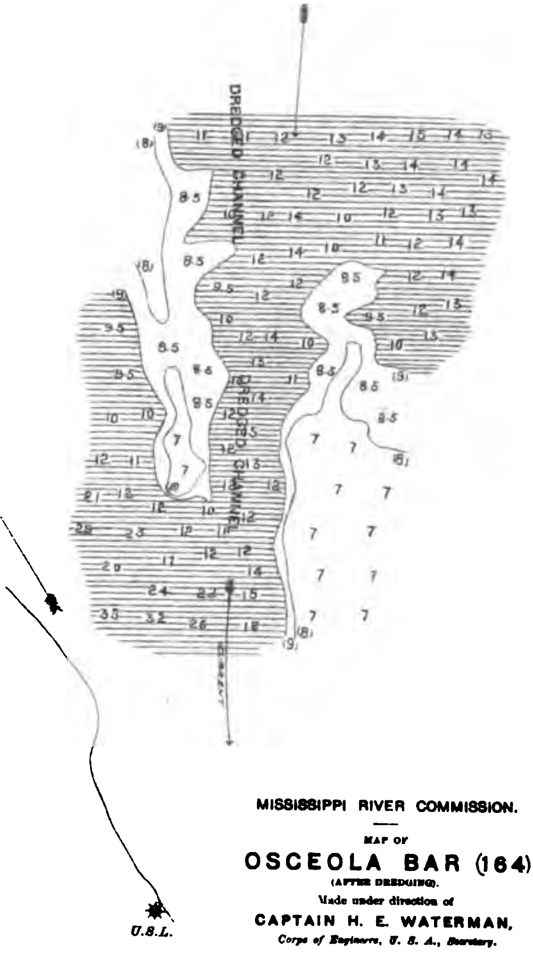
SCALE OF FEET:

400 200 0 200 400 600 800

NOTE.—Soundings are referred to mean low water on Fulton gauge, which corresponds to a reading of 3.88 feet.

Gauge at time of survey 2.8 feet, or 1.08 feet below mean low water.

PLATE 68.



MISSISSIPPI RIVER COMMISSION.

MAP OF

OSCEOLA BAR (164)

(AFTER DREDGING).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 12, 1897.

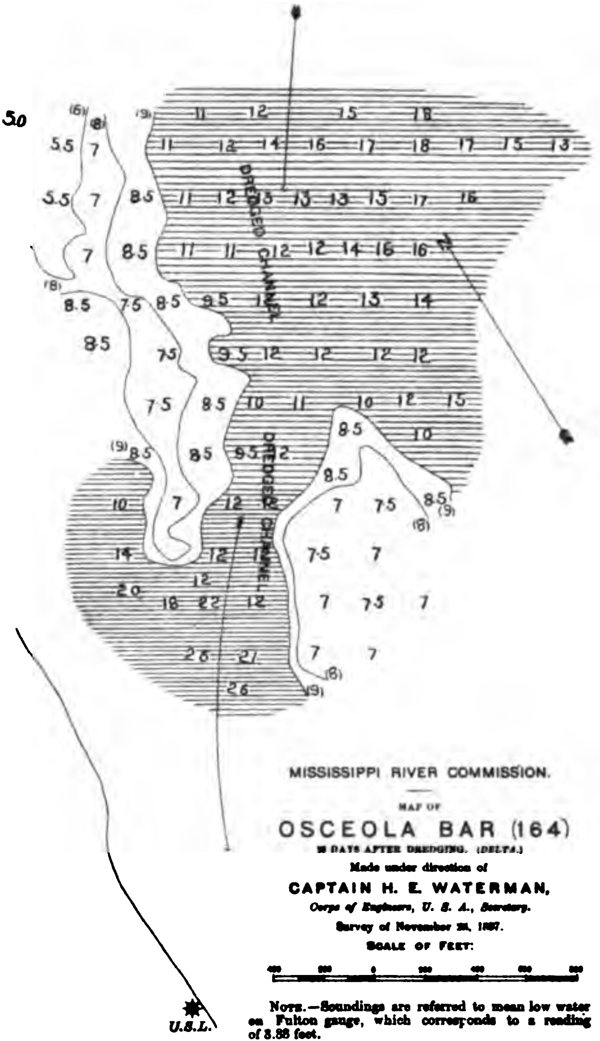
SCALE OF FEET:

NOTE.—Soundings are referred to mean low water on Fulton gauge, which corresponds to a reading of 3.88 feet.

Gauge at time of survey 2.85 feet, or 1.03 feet below mean low water.

PLATE 69.

Eng 55. 3



MISSISSIPPI RIVER COMMISSION.

MAP OF

OSCEOLA BAR (164)

[illegible] DAYS AFTER DREDGING. (DELTA.)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

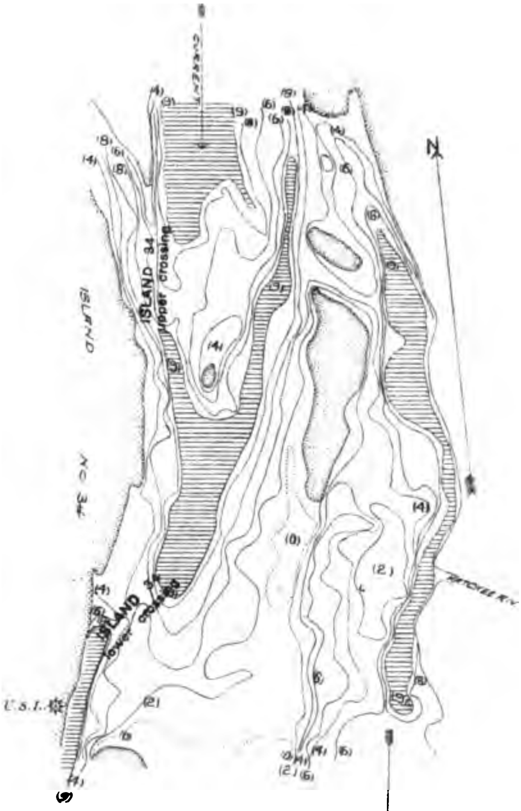
Survey of November [illegible], 1897.

SCALE OF FEET:

NOTE.—Soundings are referred to mean low water on Fulton gauge, which corresponds to a reading of 3.88 feet.

Gauge at time of survey 4.80 feet, or 0.92 feet above mean low water.

PLATE 70.



MISSISSIPPI RIVER COMMISSION.

MAP OF

VICINITY OF ISLAND NO. 34 (179)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of September 7-9-13-14-20 and October 1, 1897.

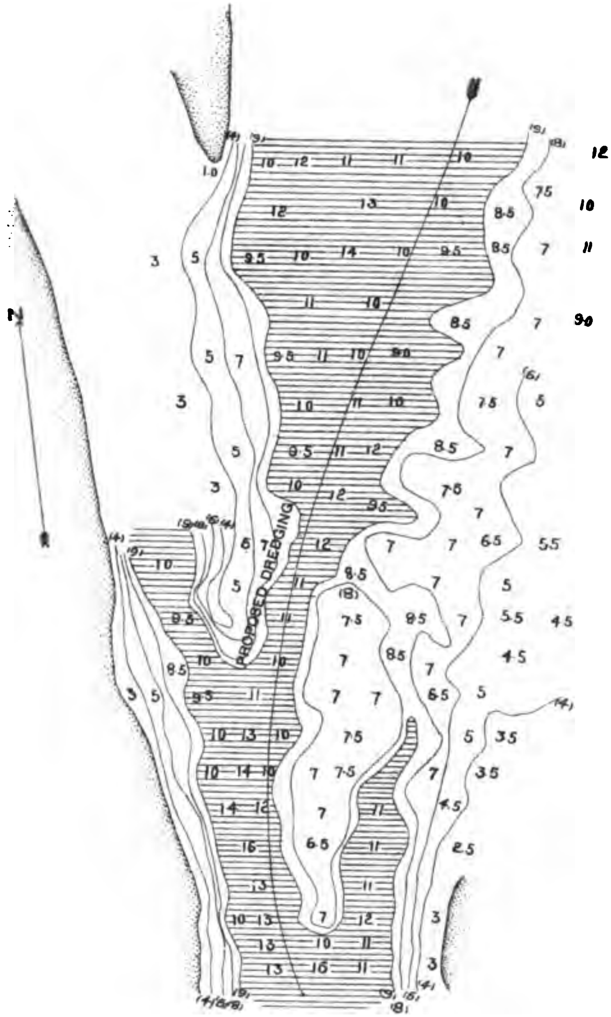
SCALE OF FEET:

1000 8 6 4 2 0 1000 2000 3000 4000

NOTE.—Soundings are referred to mean low water on Fulton gauge, which corresponds to a reading of 3.88 feet.

Gauge at time of survey 7.4 feet to 4.25 feet, or 3.52 feet to 0.37 feet above mean low water.

PLATE 71.



MISSISSIPPI RIVER COMMISSION.

MAP OF

UPPER BAR (178) IN THE VICINITY OF ISLAND NO. (34)

(BEFORE DREDGING).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of October 19-20, 1897.

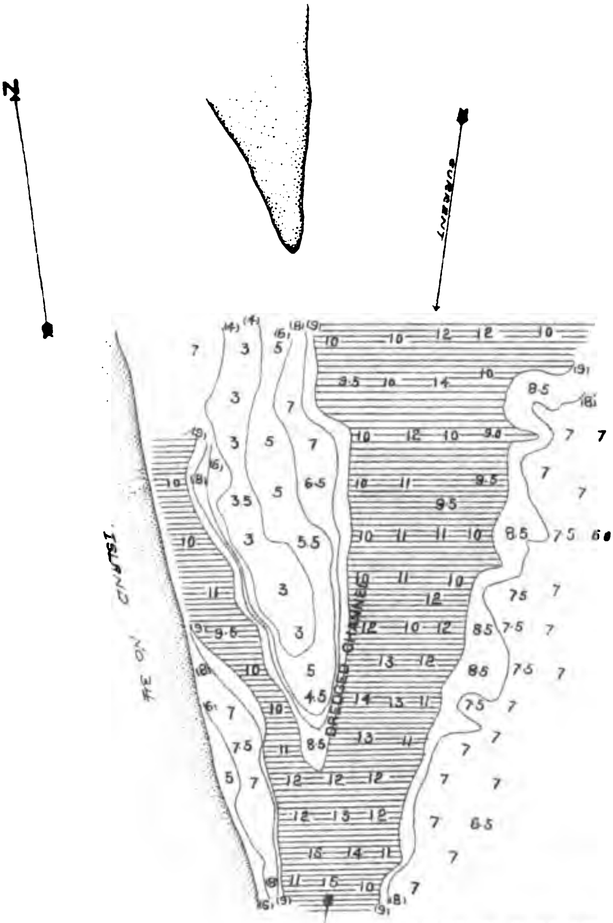
SCALE OF FEET:

400 200 0 200 400 600 800

NOTE.—Soundings are referred to mean low water on Fulton gauge, which corresponds to a reading of 3.88 feet.

Gauge at time of survey 3.0 feet to 2.9 feet, or 0.9 foot to 1.0 feet below mean low water.

PLATE 72.



MISSISSIPPI RIVER COMMISSION.

MAP OF

UPPER BAR (178) IN THE VICINITY OF ISLAND NO. (34)

9 DAYS AFTER DREDGING (*DELTA.*)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of October 29, 1897.

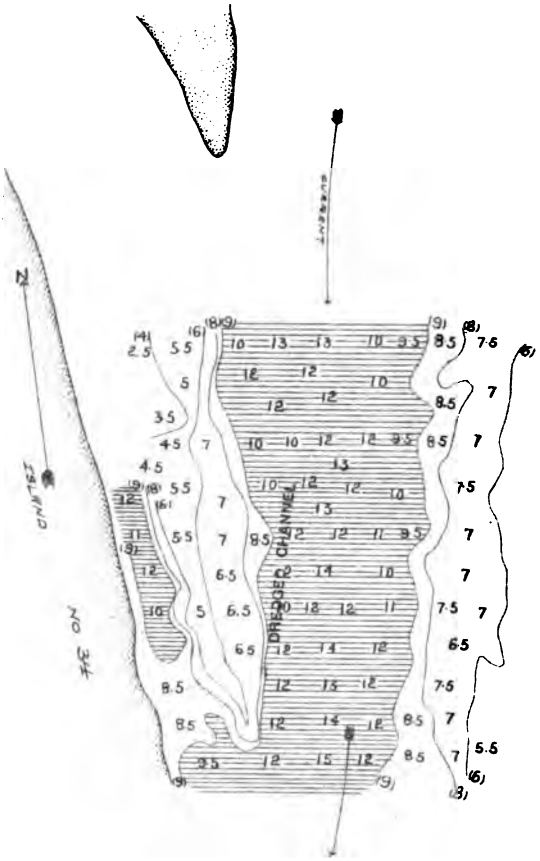
SCALE OF FEET:

400 200 0 200 400 600 800

NOTE.—Soundings are referred to mean low water on Fulton gauge, which corresponds to a reading of 3.88 feet.

Gauge at time of survey 2.75 feet, or 1.18 feet below mean low water.

PLATE 73.



MISSISSIPPI RIVER COMMISSION.

MAP OF

UPPER BAR (178) IN THE VICINITY OF ISLAND NO. (34)

[illegible] DAYS AFTER DREDGING. *(DELTA.)*

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

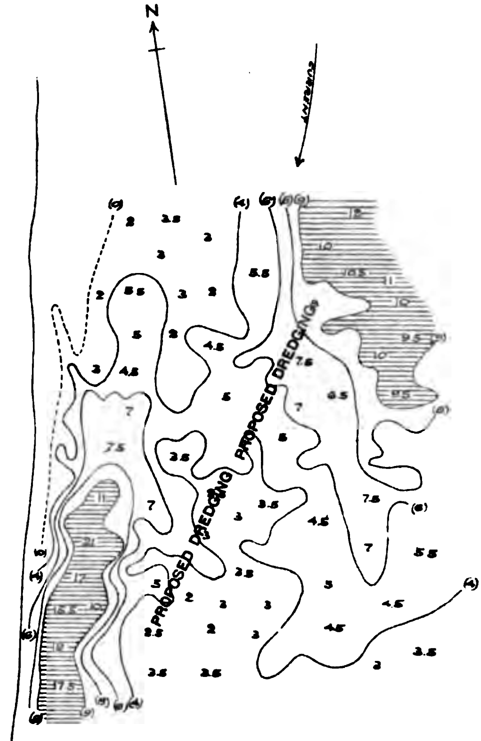
Survey of November 24, 1897.

SCALE OF FEET:

NOTE.—Soundings are referred to mean low water on Fulton gauge, which corresponds to a reading of 3.88 feet.

Gauge at time of survey 4.45 feet, or 0.57 feet above mean low water.

PLATE 74.



MISSISSIPPI RIVER COMMISSION.

MAP OF

HYDROGRAPHICAL SURVEY OF MISSISSIPPI RIVER, VICINITY OF ISLAND NO. 34 (179) R

(BEFORE DREDGING).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of September 7-9, 1897.

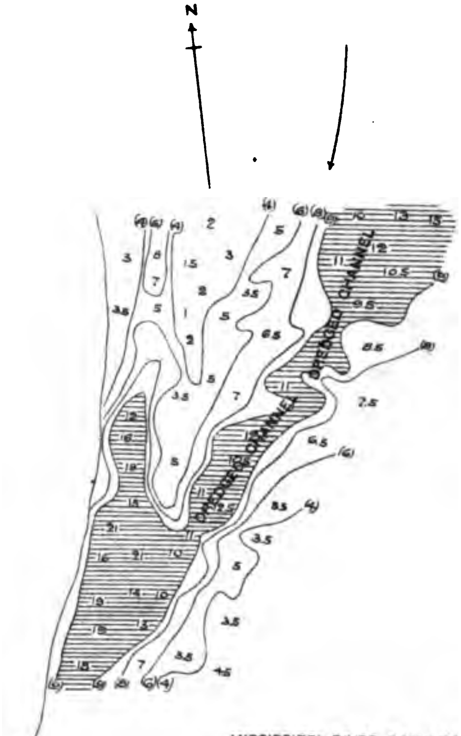
SCALE OF FEET:

400 200 0 200 400 600 800

NOTE.—Soundings are referred to mean low water on Fulton gauge, which corresponds to a reading of 3.88 feet.

Gauge at time of survey 7.4 feet to 4.25 feet, or 3.52 feet to 0.37 feet above mean low water.

PLATE 75.



MISSISSIPPI RIVER COMMISSION.

MAP OF

HYDROGRAPHICAL SURVEY OF MISSISSIPPI RIVER,

VICINITY OF ISLAND NO. 34 (178) R

([illegible] DAYS AFTER DREDGING).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

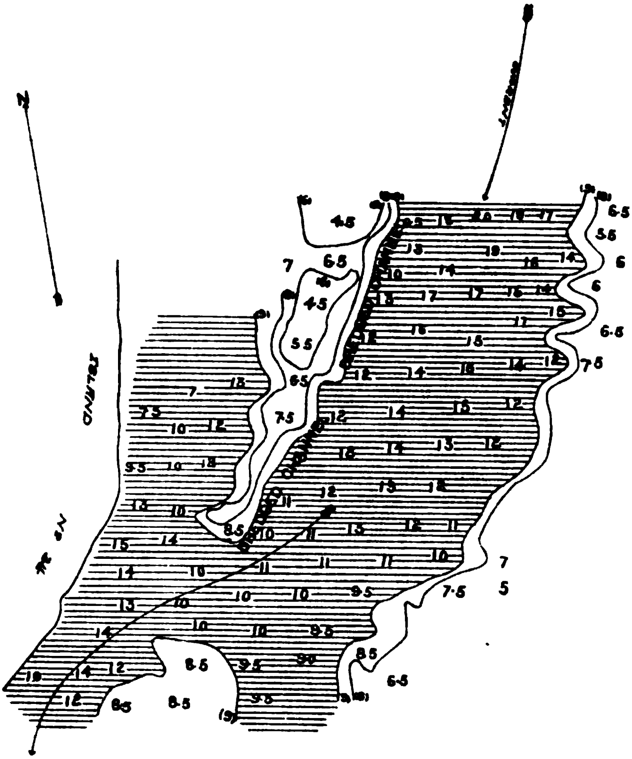
Survey of September 18, 1897.

SCALE OF FEET:

NOTE.—Soundings are referred to mean low water on Fulton gauge, which corresponds to a reading of 3.88 feet.

Gauge at time of survey 5.38 feet, or 1.5 feet above mean low water.

PLATE 78.



MISSISSIPPI RIVER COMMISSION.

MAP OF

LOWER BAR (179) IN THE VICINITY OF ISLAND No. 34

60 DAYS AFTER DREDGING. (DELTA.)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 24, 1897.

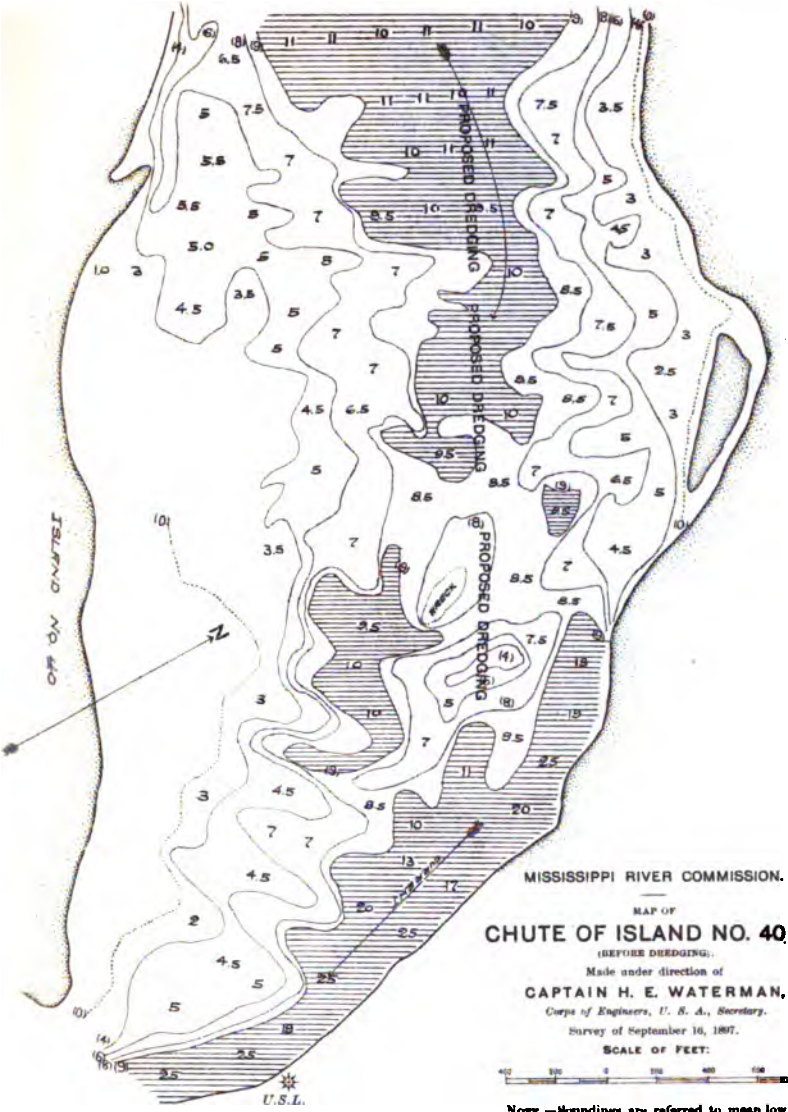
SCALE OF FEET:

400 200 0 200 400 600 800

NOTE.—Soundings are referred to mean low water on Fulton gauge, which corresponds to a reading of 3.88 feet.

Gauge at time of survey 4.45 feet, or 0.57 feet above mean low water.

PLATE 77.



MISSISSIPPI RIVER COMMISSION.

MAP OF

CHUTE OF ISLAND NO. 40 (211)

(BEFORE DREDGING).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of September 16, 1897.

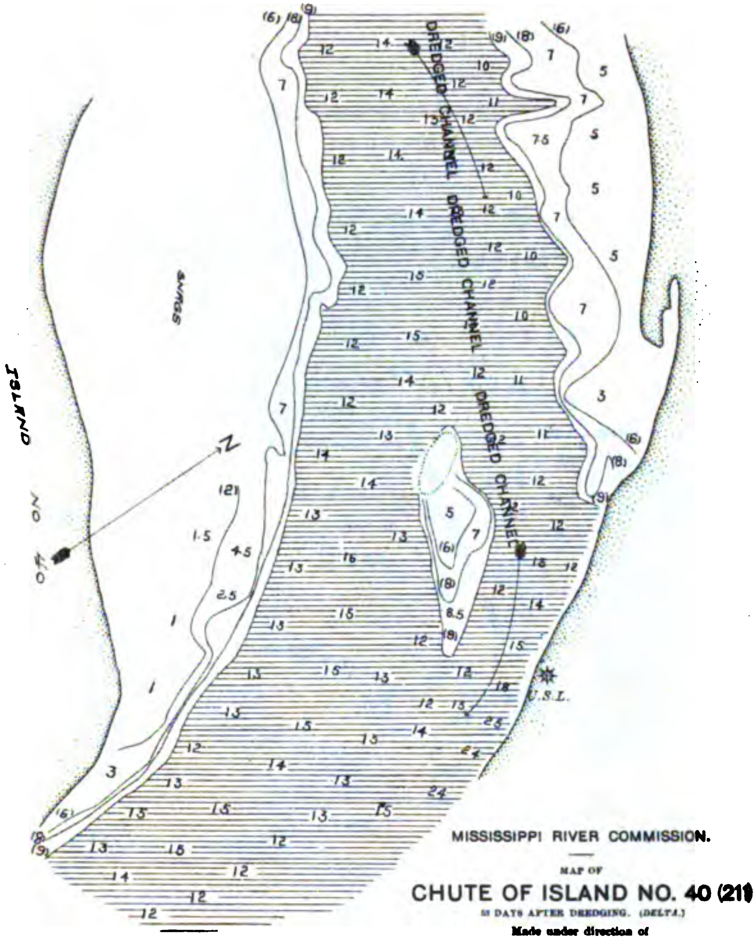
SCALE OF FEET:

Note.—Soundings are referred to mean low water on Memphis gauge, which corresponds to a reading of 1.85 feet.

Gauge at time of survey 2.85 feet, or 1.0 feet above mean low water.

PLATE 78.

Eng 55 3



MISSISSIPPI RIVER COMMISSION.

MAP OF

CHUTE OF ISLAND NO. 40 (21)

15 DAYS AFTER DREDGING. (DELTA.)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 22, 1897.

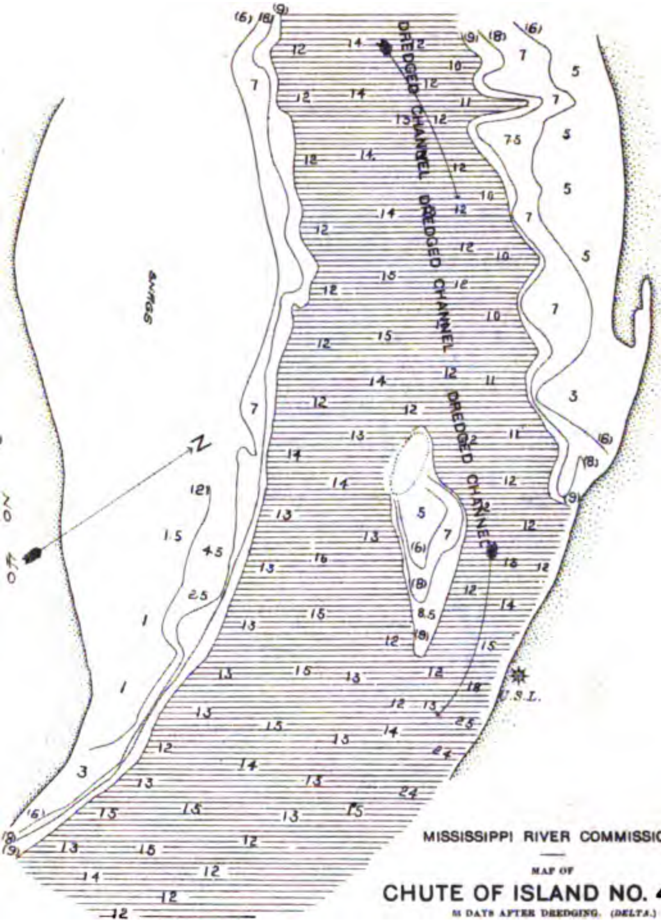
SCALE OF FEET:

NOTE.—Soundings are referred to mean low water on Memphis gauge, which corresponds to a reading of 1.85 feet.

Gauge at time of survey 2.1 feet, or 0.25 feet above mean low water.

PLATE 80.

Eng 55 3



MISSISSIPPI RIVER COMMISSION.

MAP OF

CHUTE OF ISLAND NO. 40 (21)

31 DAYS AFTER DREDGING. (DELTA.)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 22, 1897.

SCALE OF FEET:

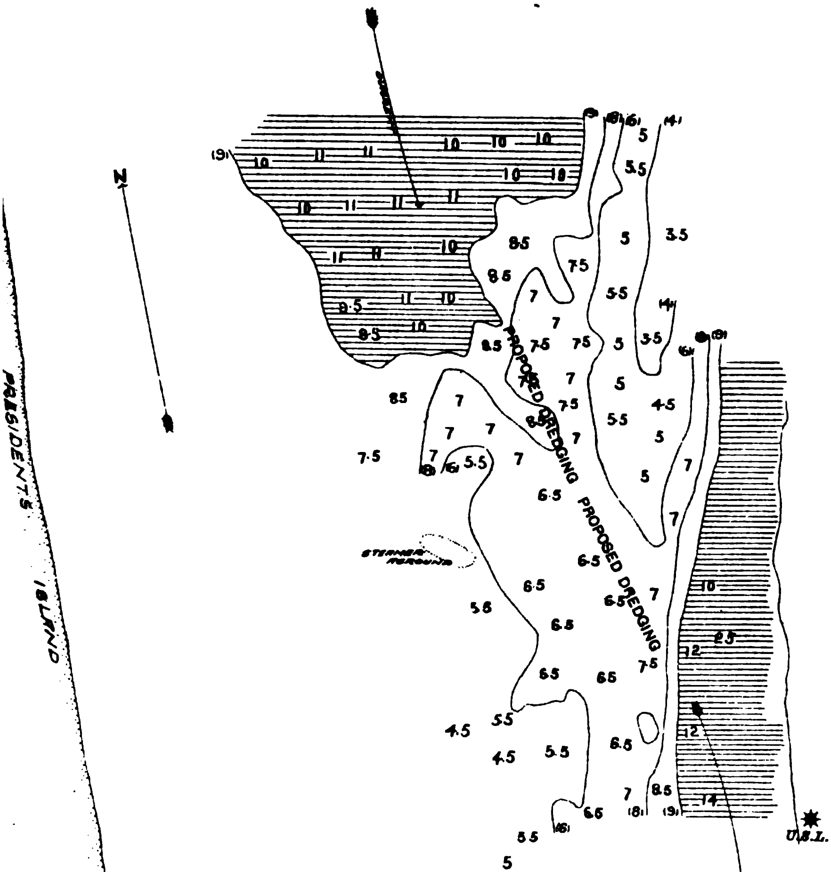
400 200 0 200 400 600 800

NOTE.—Soundings are referred to mean low water on Memphis gauge, which corresponds to a reading of 1.85 feet.

Gauge at time of survey 2.1 feet, or 0.25 feet above mean low water.

PLATE 80.

Eng 55 3



MISSISSIPPI RIVER COMMISSION.

MAP OF

VICINITY OF PRESIDENTS ISLAND NO. 45 (236)

(BEFORE DREDGING).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of October 4-7-8, 1897.

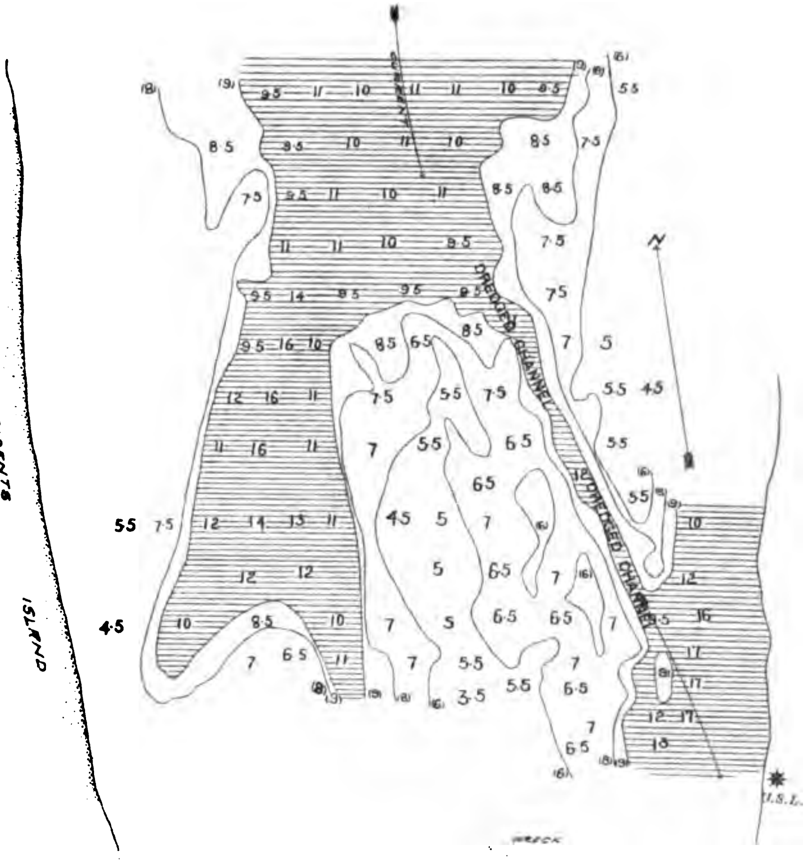
SCALE OF FEET:

NOTE.—Soundings are referred to mean low water on Memphis gauge, which corresponds to a reading of 1.85 feet.

Gauge at time of survey 0.5 feet, or 0.9 feet below mean low water.

PLATE 81.

Eng 55 3



MISSISSIPPI RIVER COMMISSION.

MAP OF

VICINITY OF PRESIDENTS ISLAND NO. 45 (236)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of October 21, 1897.

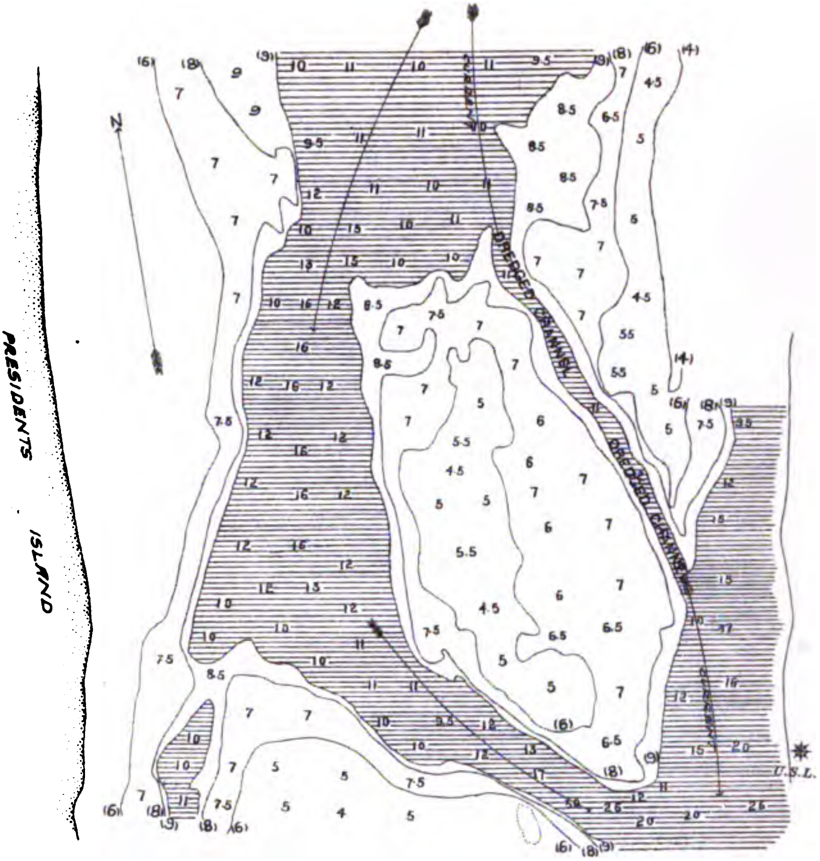
SCALE OF FEET:

400 200 0 200 400 600 800

NOTE.—Soundings are referred to mean low water on Memphis gauge, which corresponds to a reading of 1.85 feet.

Gauge at time of survey 0.45 feet, or 1.4 feet below mean low water.

PLATE 82.



MISSISSIPPI RIVER COMMISSION.

MAP OF

VICINITY OF PRESIDENTS ISLAND NO. 45 (236)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 8, 1897.

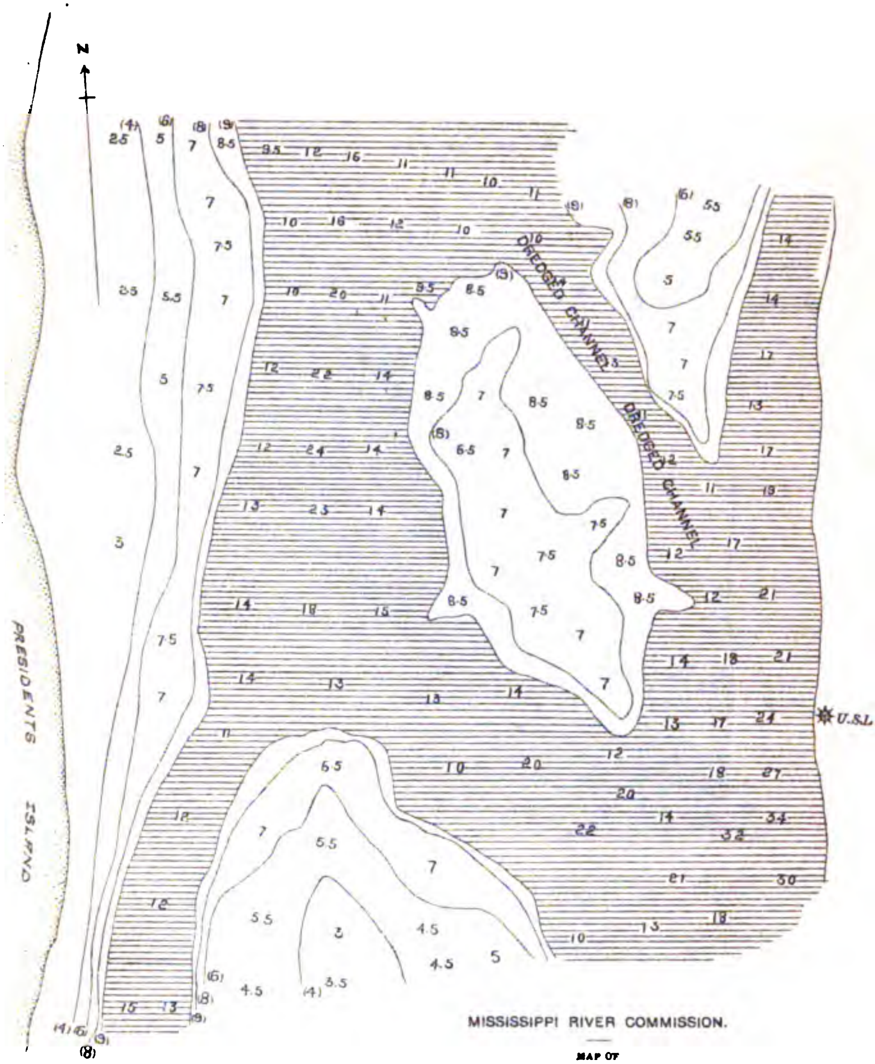
SCALE OF FEET:

400 200 0 200 400 600 800

NOTE.—Soundings are referred to mean low water on Memphis gauge, which corresponds to a reading of 1.85 feet.

Gauge at time of survey 0.6 feet, or 1.25 feet below mean low water.

PLATE 83.



MISSISSIPPI RIVER COMMISSION.

MAP OF

VICINITY OF PRESIDENTS ISLAND NO. 45 (235)

10 DAYS AFTER DREDGING. *(DELTA.)*

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of December 17, 1897.

SCALE OF FEET:

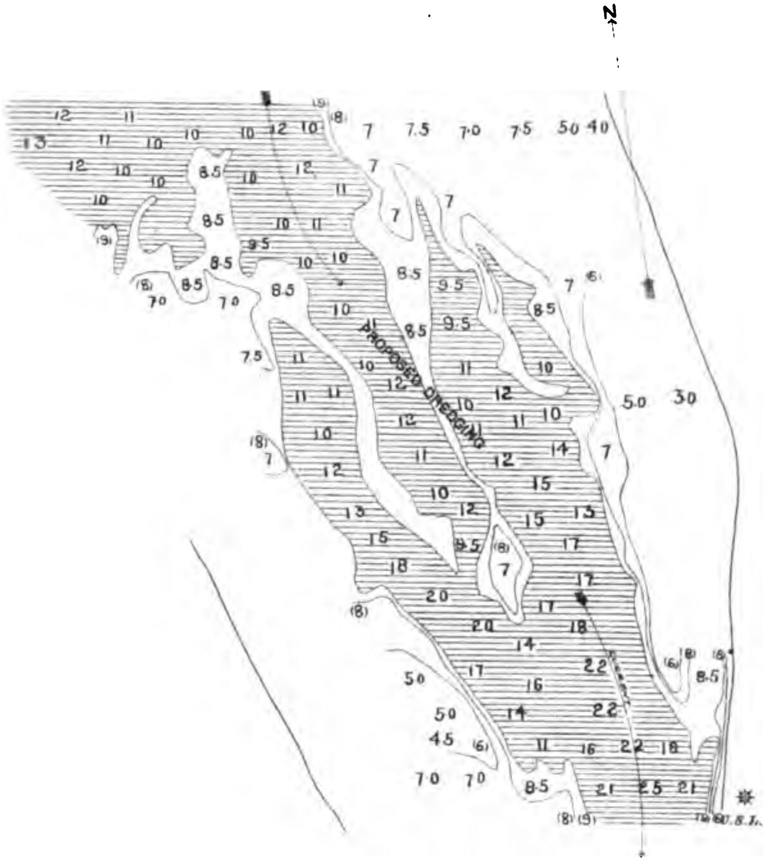
400 200 0 200 400 600 800

NOTE.—Soundings are referred to mean low water on Memphis gauge, which corresponds to a reading of 1.85 feet.

Gauge at time of survey 4.85 feet, or 3.0 feet above mean low water.

PLATE 84.

Eng 55 3



MISSISSIPPI RIVER COMMISSION.

MAP OF

FLEECES CROSSING (243)

(BEFORE DREDGING).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 9, 1897.

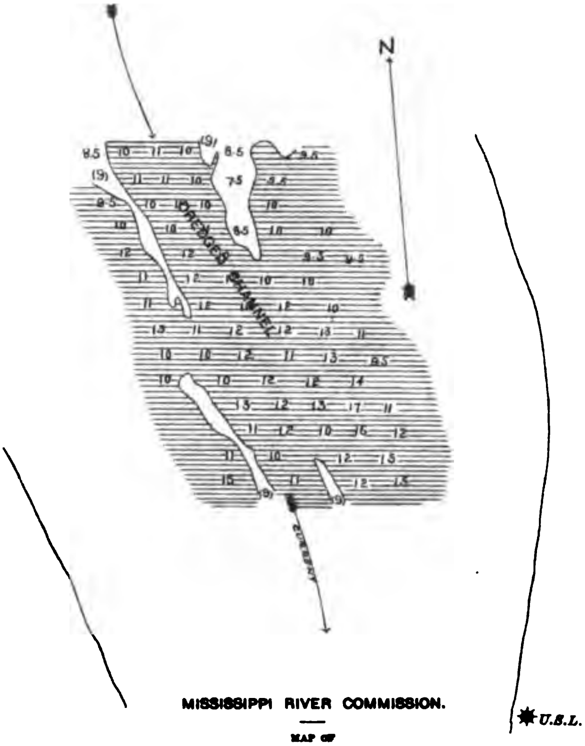
SCALE OF FEET:

600 300 0 300 600 900 1200

NOTE.—Soundings are referred to mean low water on Memphis gauge, which corresponds to a reading of 1.85 feet.

Gauge at time of survey 0.8 feet, or 1.05 feet below mean low water.

PLATE 85.



MISSISSIPPI RIVER COMMISSION.

MAP OF

FLEECES CROSSING (243)

IMMEDIATELY AFTER DREDGING. (ALPHA).

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 17, 1897.

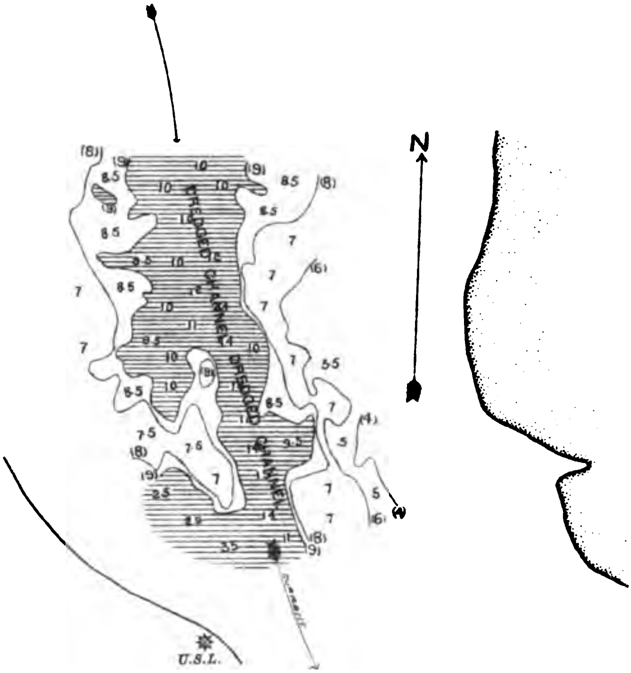
SCALE OF FEET:

600 300 0 300 600 900 1200

NOTE.—Soundings are referred to mean low water on Memphis gauge, which corresponds to a reading of 1.85 feet.

Gauge at time of survey 1.3 feet, or 0.55 feet below mean low water.

PLATE 86.



MISSISSIPPI RIVER COMMISSION.

MAP OF

VICINITY OF GRAVES BAYOU (250)

2 DAYS AFTER DREDGING. (*DELTA.*)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 18, 1897.

SCALE OF FEET:

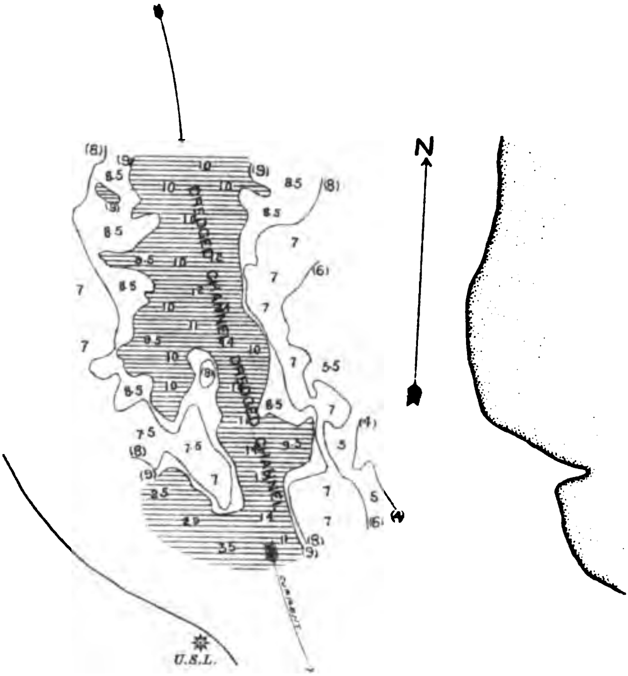
600 300 0 300 600 900 1200

NOTE.—Soundings are referred to mean low water on Memphis gauge, which corresponds to a reading of 1.85 feet.

Gauge at time of survey 1.75 feet, or 0.1 feet below mean low water.

PLATE 88.

Eng 55 3



MISSISSIPPI RIVER COMMISSION.

MAP OF

VICINITY OF GRAVES BAYOU (250)

2 DAYS AFTER DREDGING. (*DELTA.*)

Made under direction of

CAPTAIN H. E. WATERMAN,

Corps of Engineers, U. S. A., Secretary.

Survey of November 18, 1897.

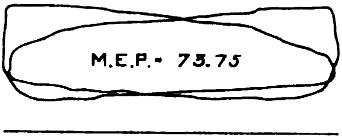
SCALE OF FEET:

600 300 0 300 600 900 1200

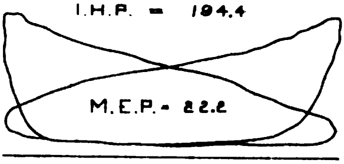
NOTE.—Soundings are referred to mean low water on Memphis gauge, which corresponds to a reading of 1.85 feet.

Gauge at time of survey 1.75 feet, or 0.1 feet below mean low water.

PLATE 88.



I.H.P. = 194.4

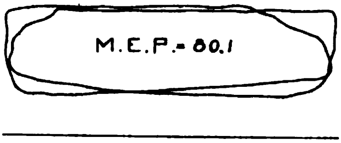


TOTAL I.H.P. 390.6

Test No. 10.

REV.- 152.

I.H.P. = 213.1



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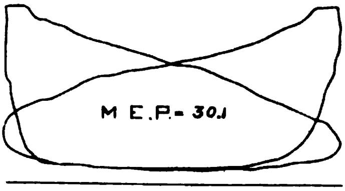

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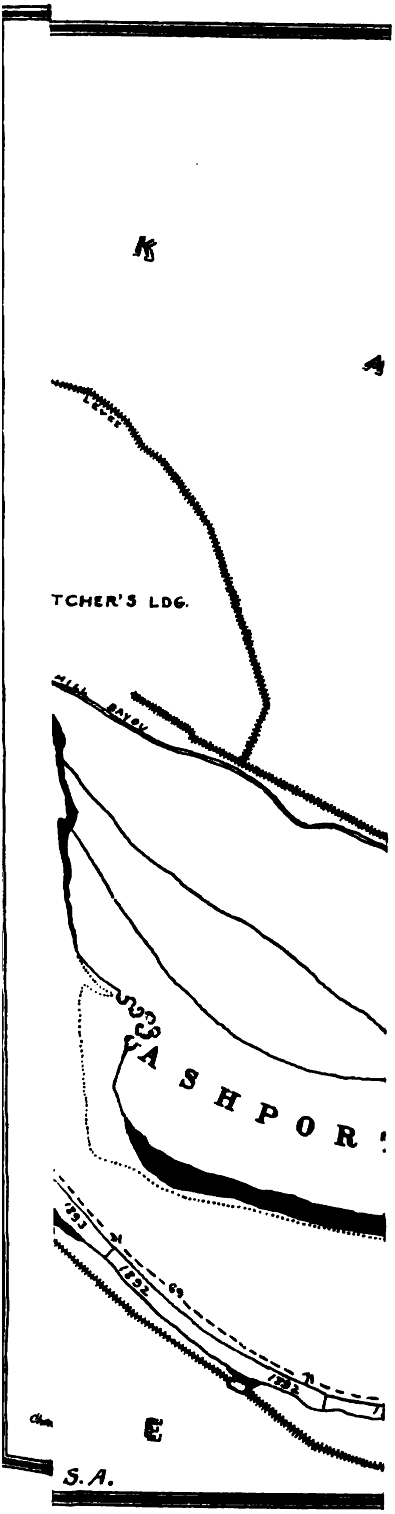
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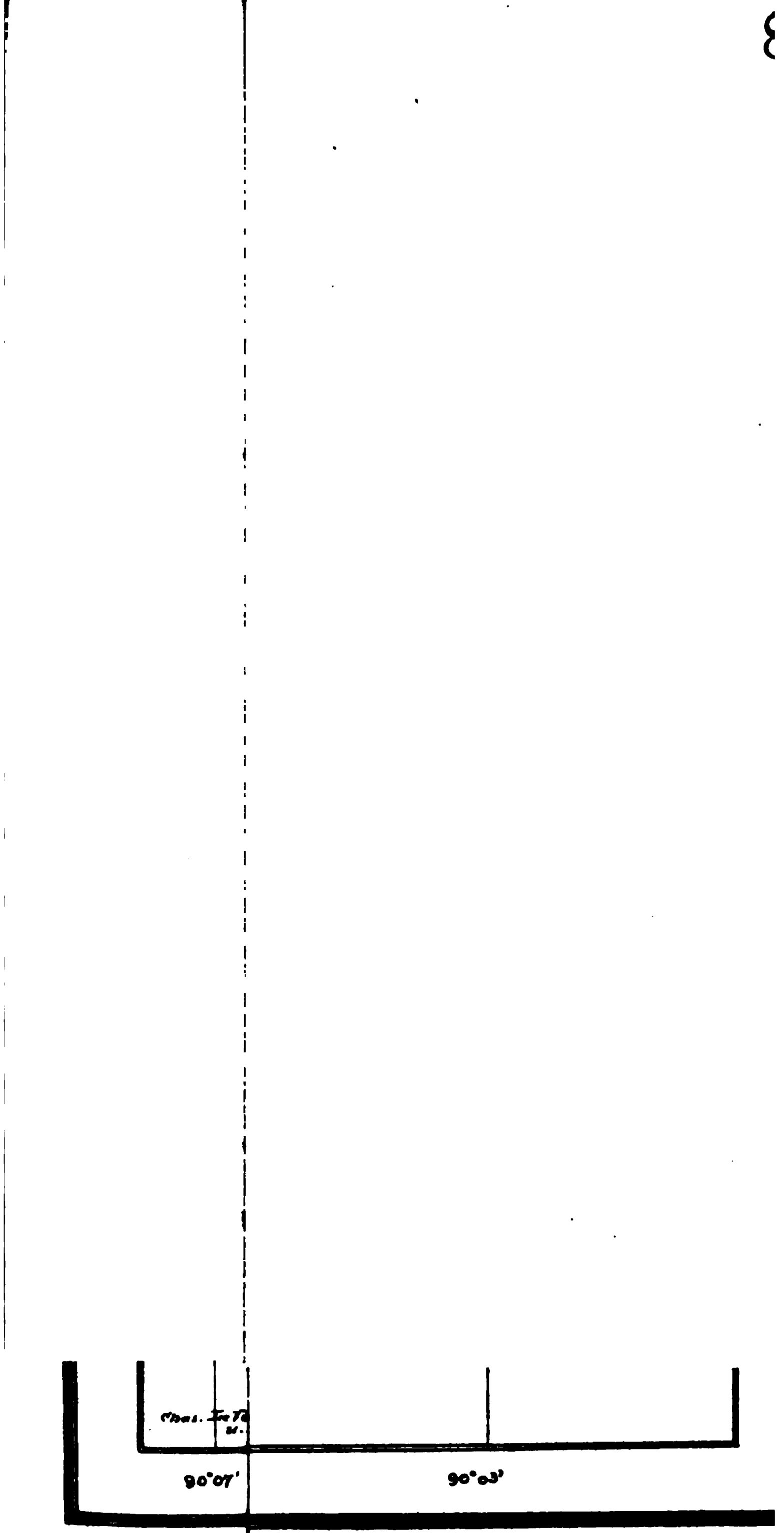

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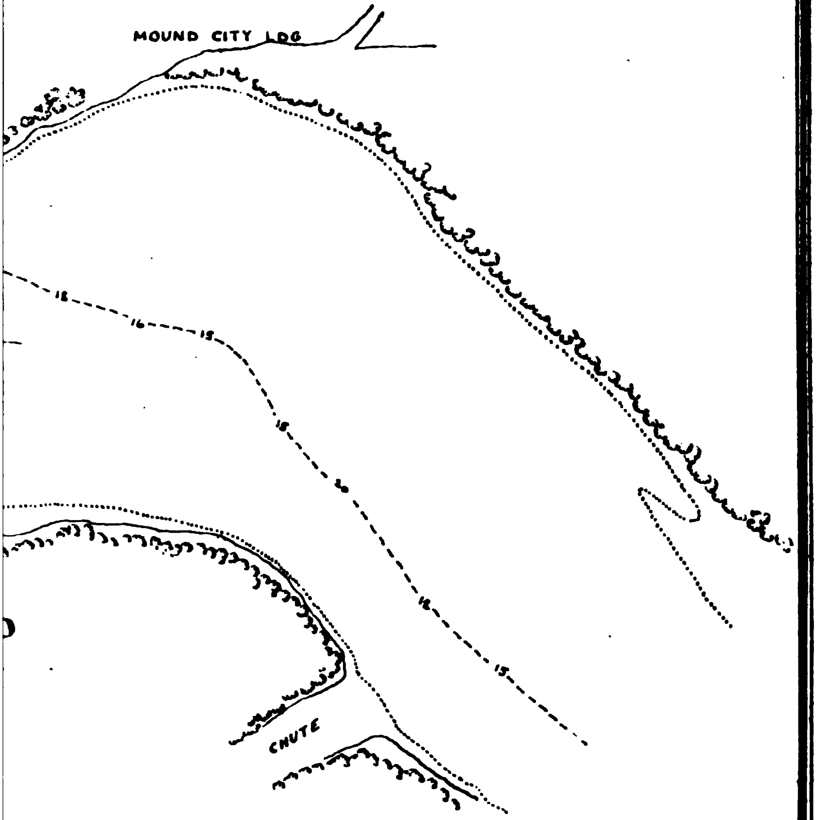

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To accompany my annual report for
the fiscal year ending June 30, 1898.

Mason M. Patrick
1st Lieut. of Engr's. U.S.A.

Scales { Hor. 1" = 15'
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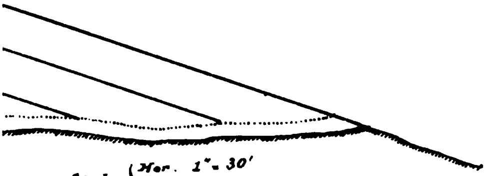

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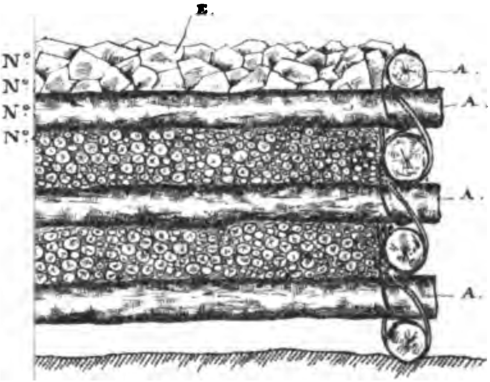

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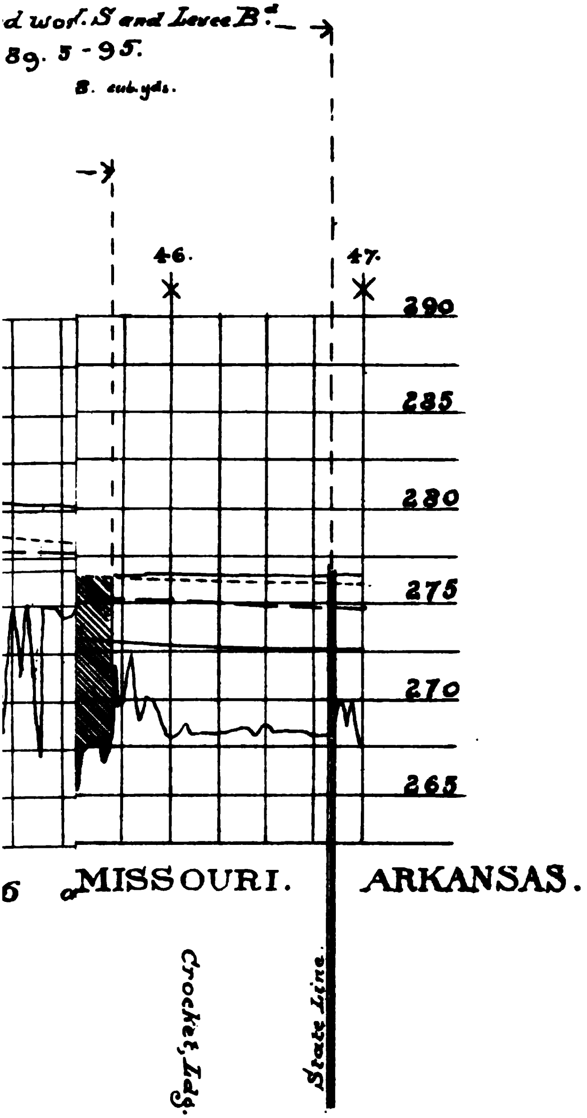
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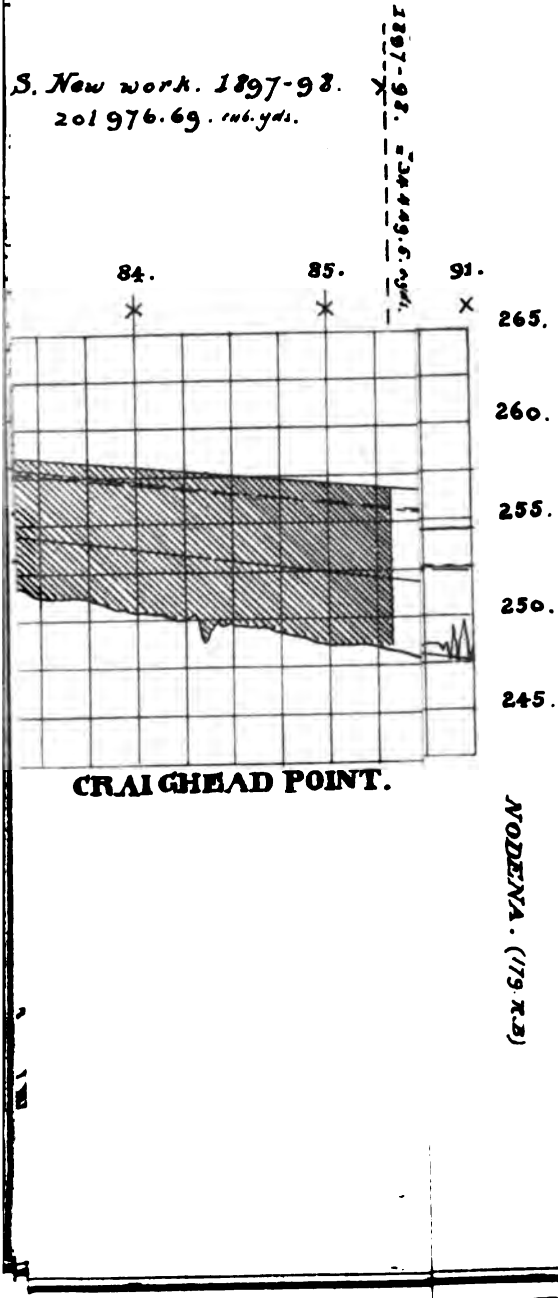
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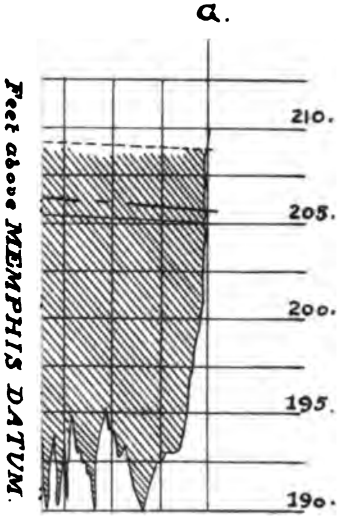

J. T. Ferguson.

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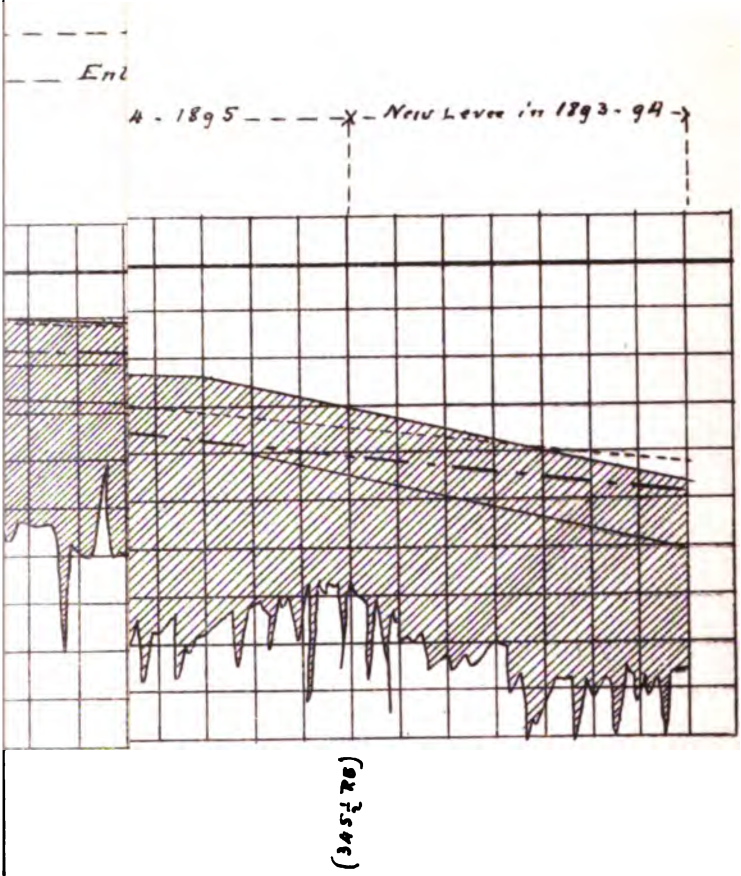

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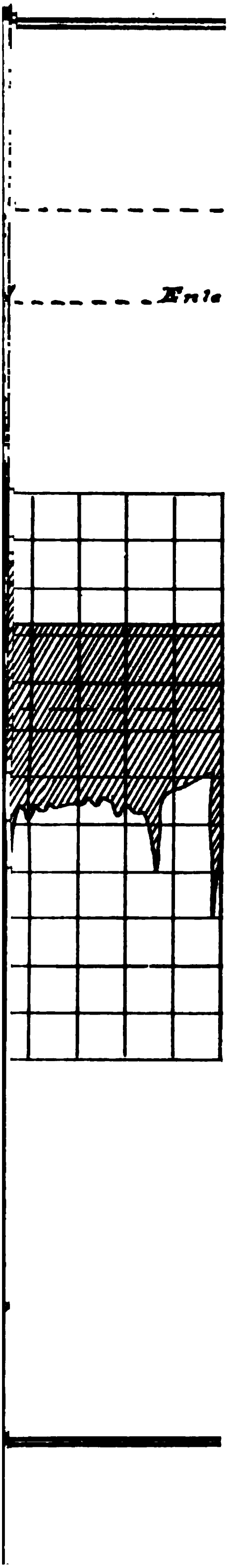
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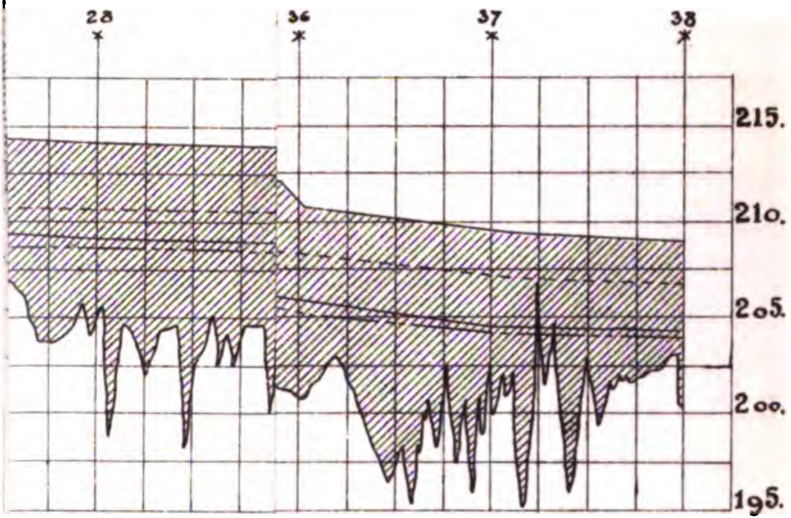

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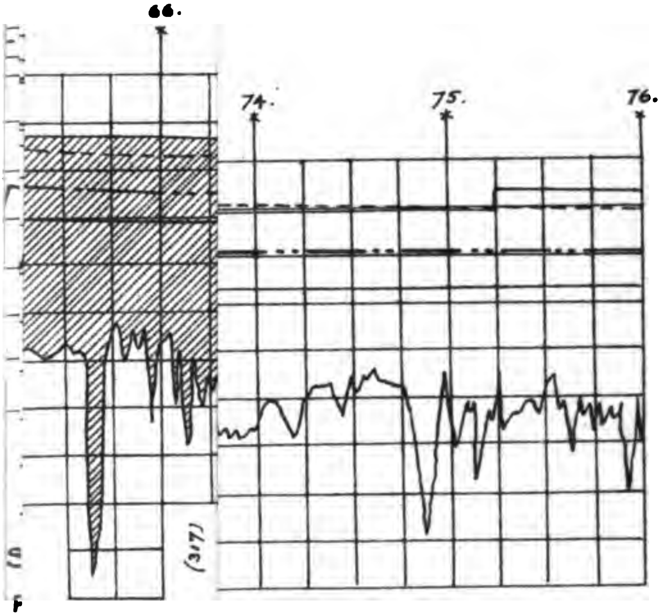

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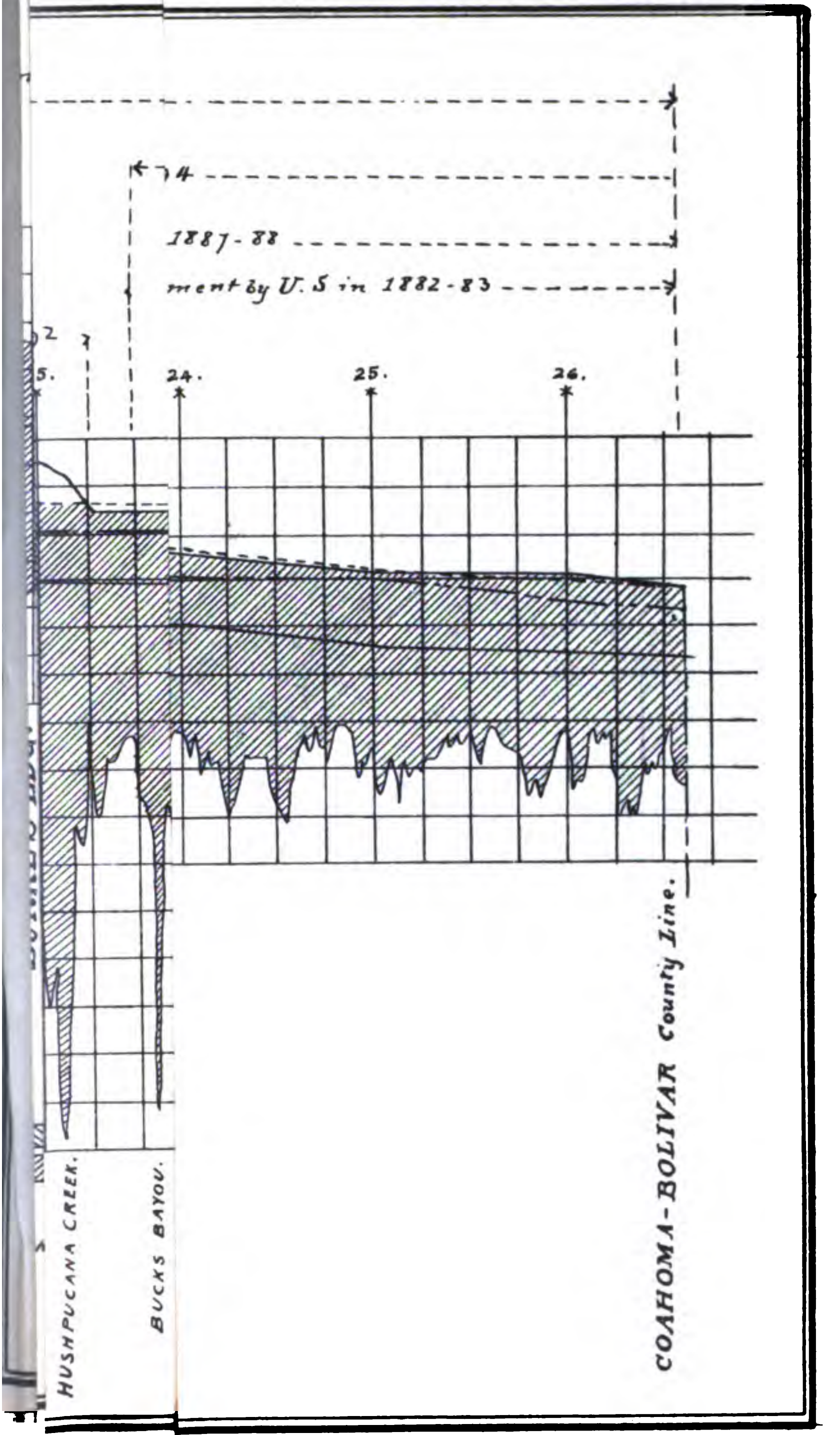
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HUSHPUCANA CREEK.
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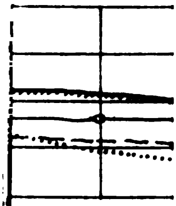

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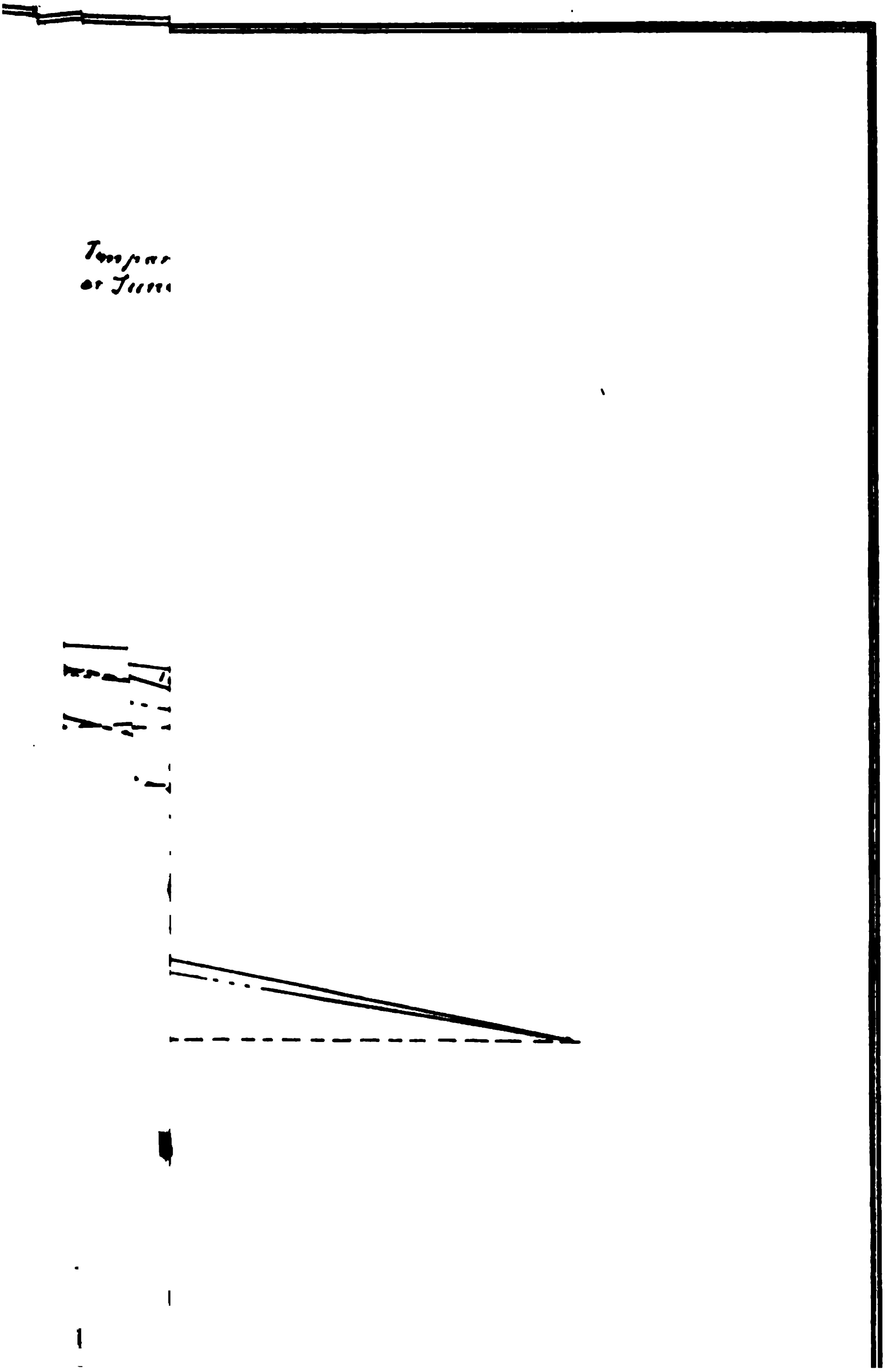
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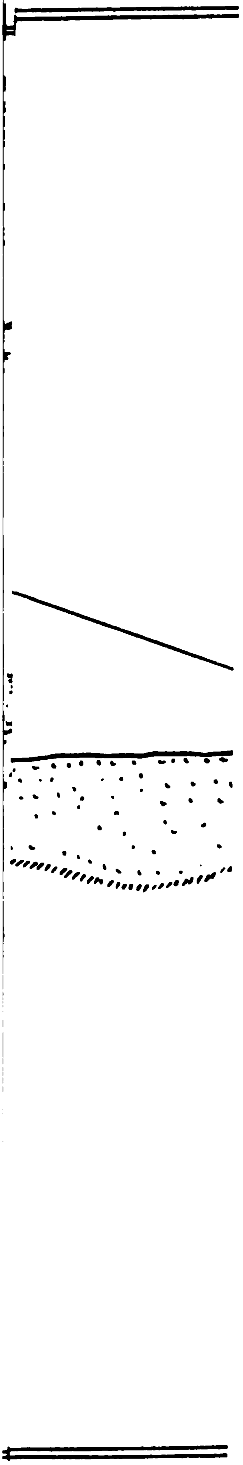

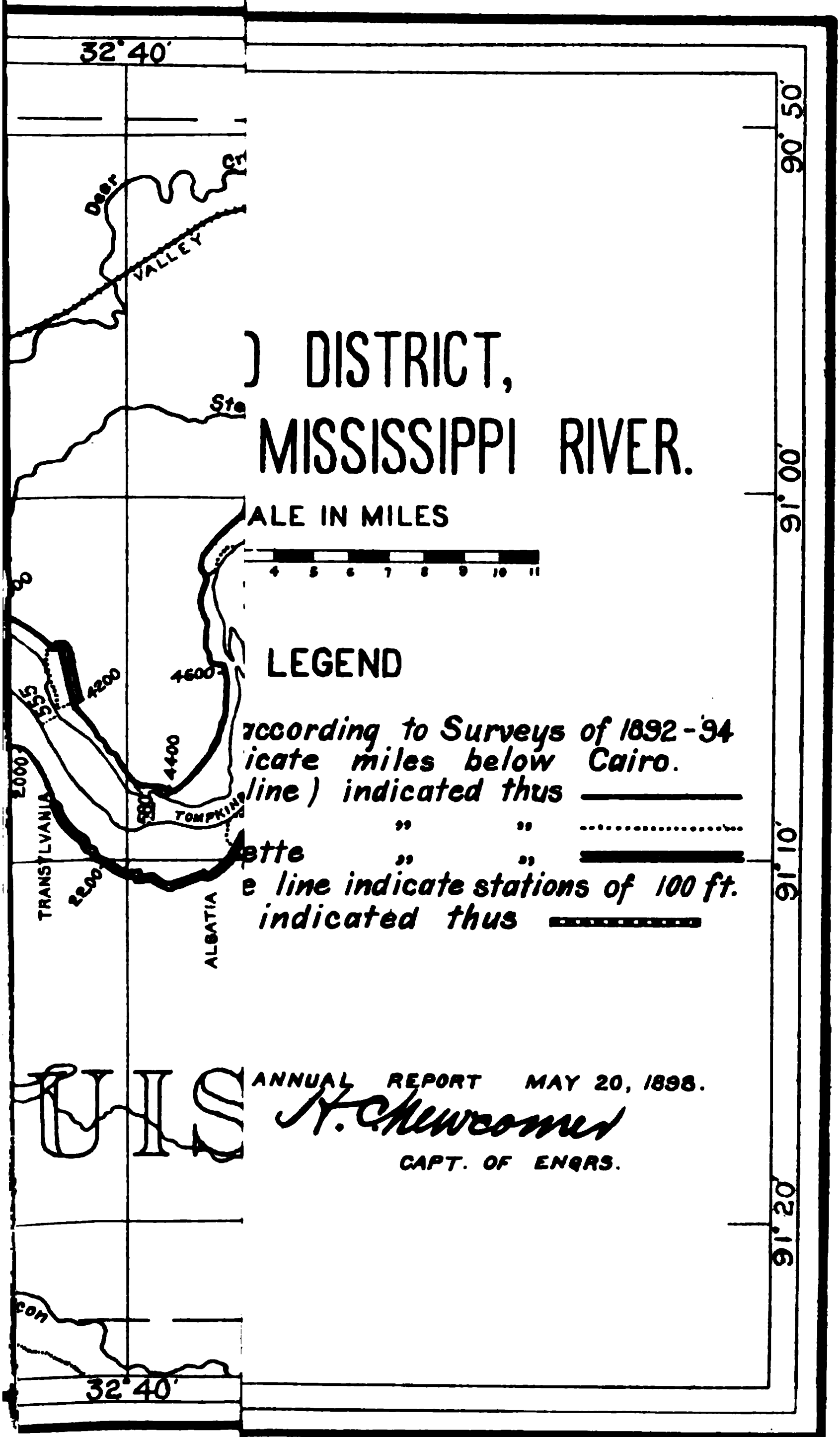

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ANNUAL REPORT MAY 20, 1898.

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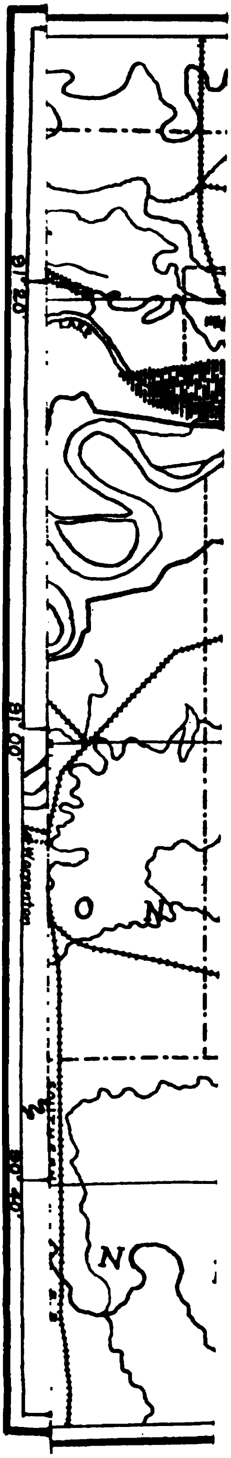
CAPT. OF ENGRS.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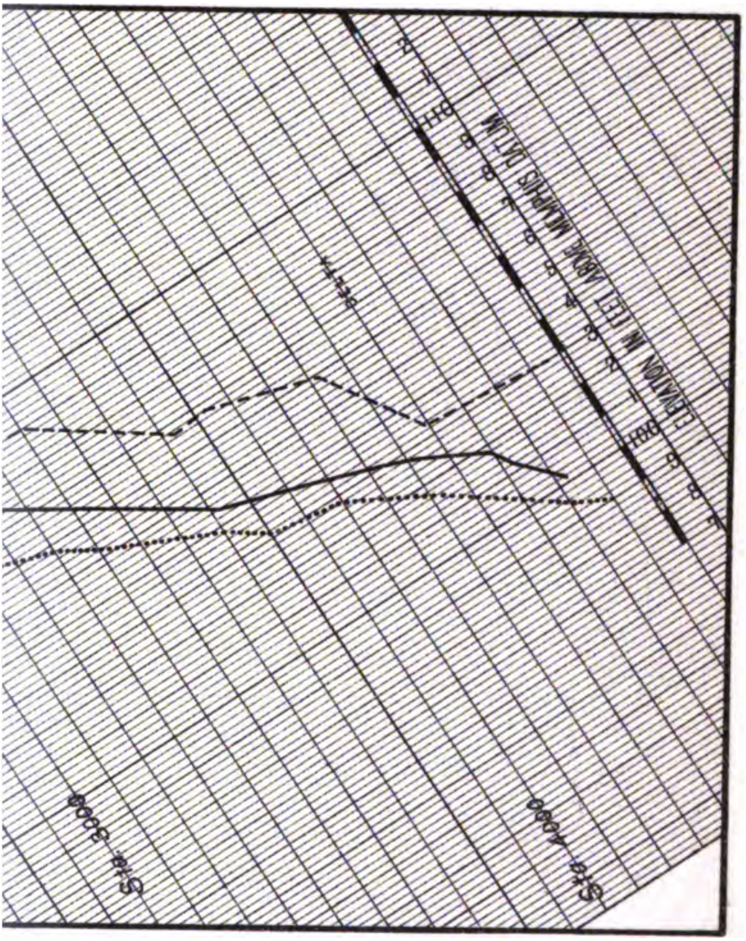

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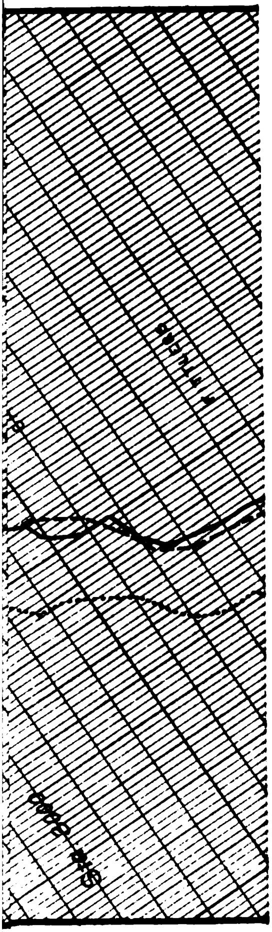
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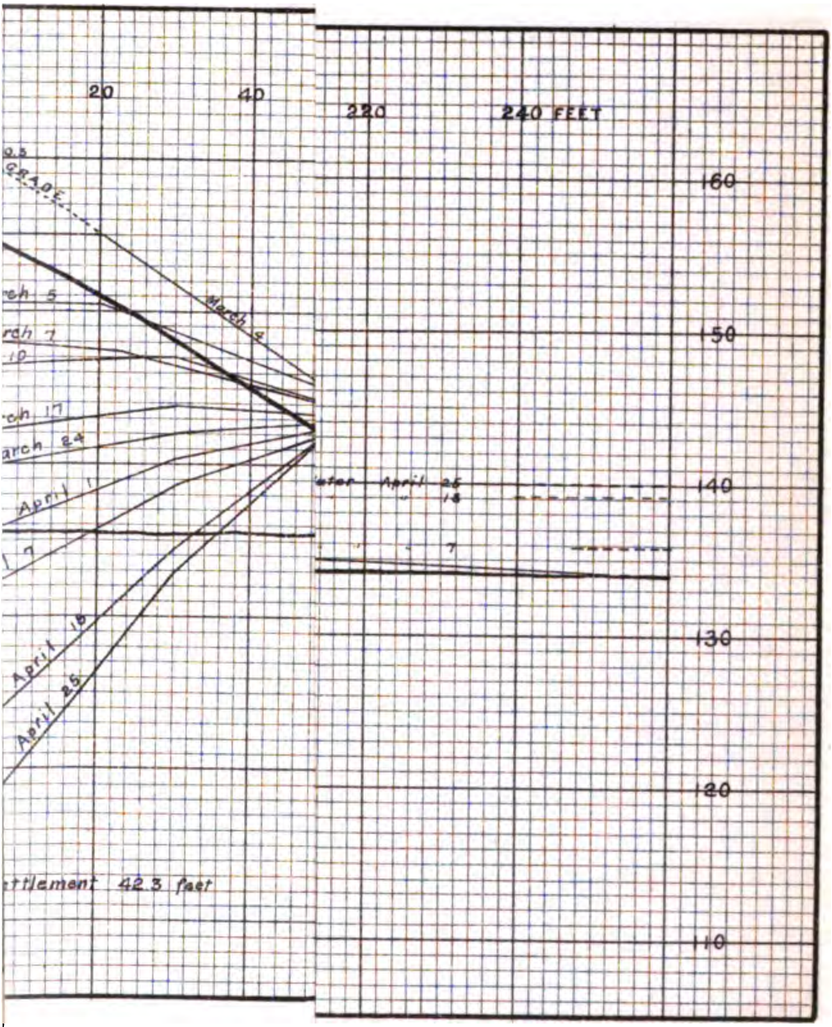
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Plate. I.

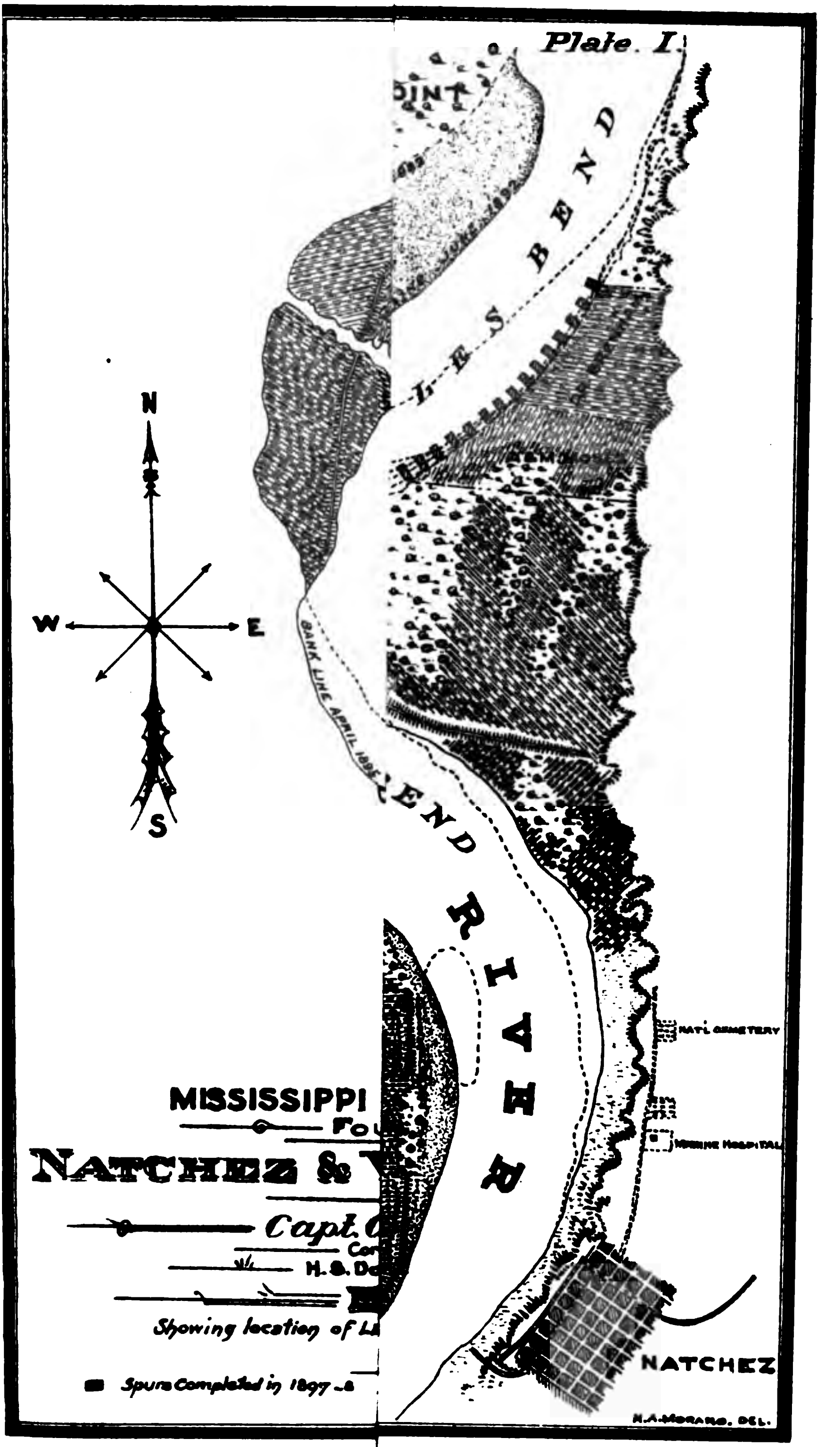

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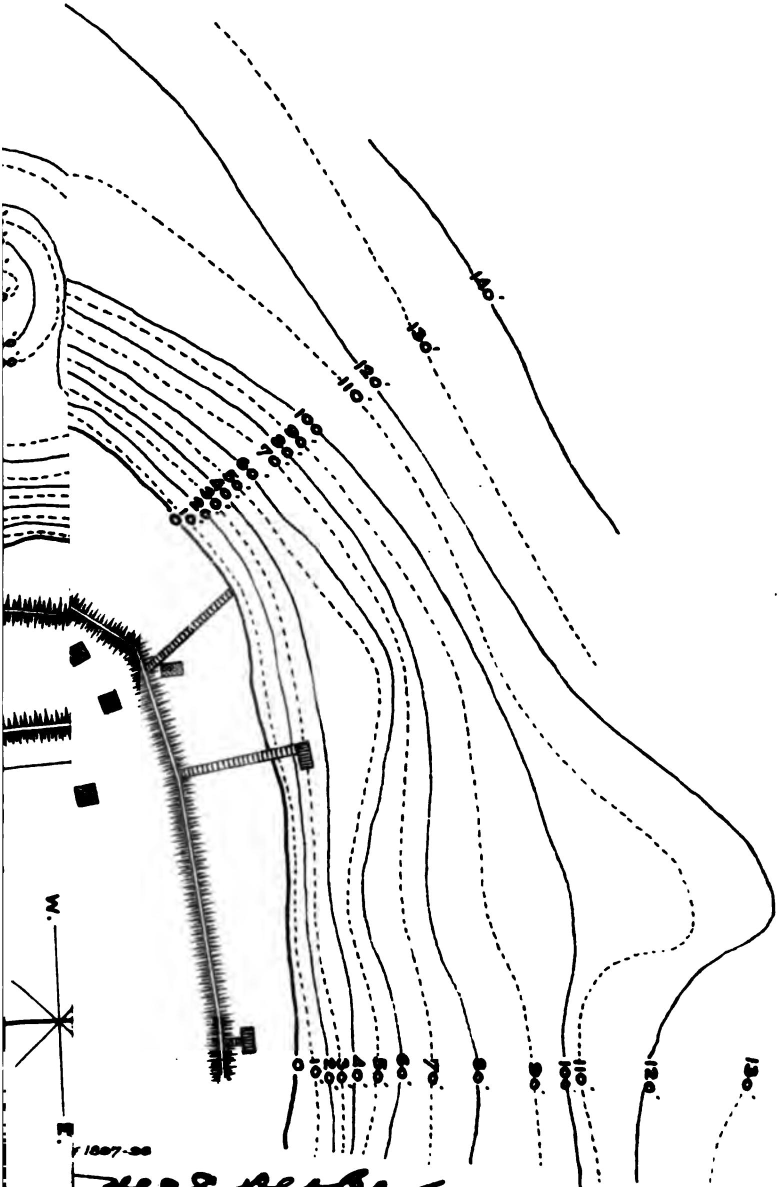
Plate II



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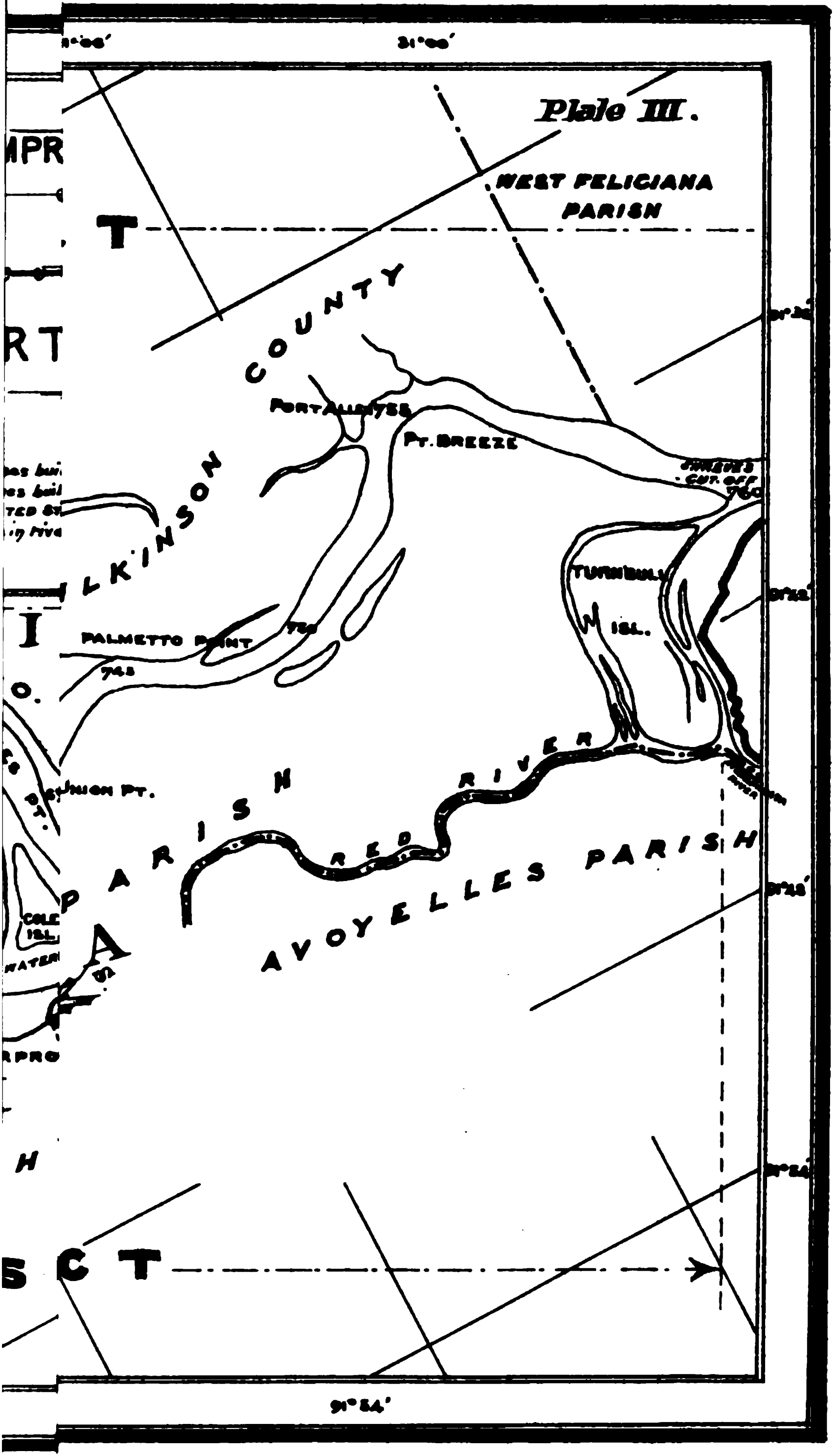
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Plate III.
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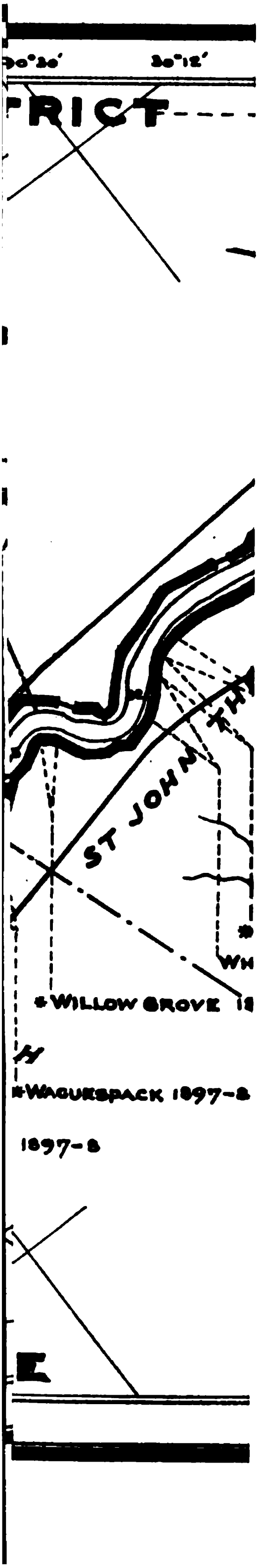
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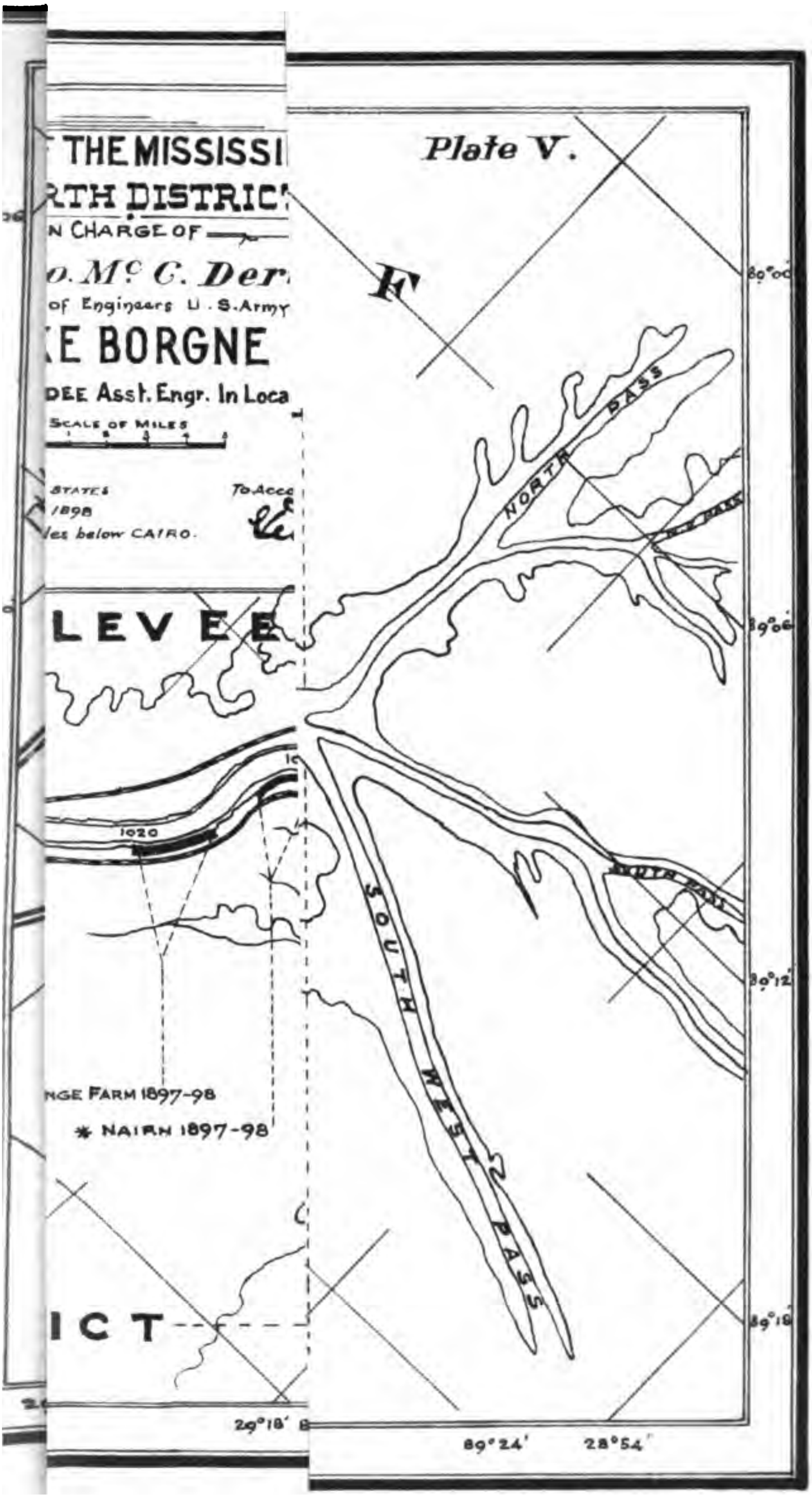
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Eng 55 3

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